PERFORMANCE SPECIFICATION

FOR THE NOAA-K, L, M, N, N', & METOP

HIGH RESOLUTION INFRARED RADIATION SOUNDER/3/4

(HIRS/3/4)

FLIGHT MODELS H301, H302, H303, H304, H305, H306, AND H307

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ATTACHMENT B, GSFC-S-480-82, PERFORMANCE SPECIFICATION FOR THE NOAA-K, L, M ,N, N'& METOP HIRS/3/4 FLIGHT MODELS H301, H302, H303, H304, H305, H306, AND H307

CCR NO.	DATE	MOD NO.	DATE	SECTION
1375	09/25/96	96	01/24/97	All
Technical Memo (1552A)	08/14/98	120	08/19/98	Table 6
1552A	08/14/98	123	09/04/98	Table 6
1536	04/23/98	121	09/23/98	13.1.5
1512 1569	11/26/97 07/17/98	125	10/16/98	Appendix B
1613	02/01/00	157	04/03/00	2.3
1751	08/22/00	169	10/02/00	2.5
1618A	06/30/99	177	02/07/01	2.5,6.1.2,6.3
1521	02/11/00	172	12/06/00	Appendix B waiver table
1639	06/17/99	172	12/06/00	Appendix B waiver table
1821	06/04/01	205	12/12/01	6.1.9
1818	10/30/01	211	02/28/02	Appendix B waiver table
1872	10/30/01	214	03/18/02	Appendix B waiver table
1830A	05/22/02	198	09/13/02	10.4.3, 10.4.4, 10.4.5
1786B	09/16/02	242	10/16/02	6.1.16
1933	06/20/02	245	12/23/02	9.2
1969	01/28/03	256	04/17/03	11.3.2.3

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APPENDIX A

APPENDIX B

ILLUSTRATIONS

TABLES

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PERFORMANCE SPECIFICATION

FOR THE

HIGH RESOLUTION INFRARED RADIATION SOUNDER/3/4

(HIRS/3/4)

1. SCOPE

This specification describes, specifies the performance of, and defines the testing and calibration of the High Resolution Infrared Radiation Sounder/3/4 (HIRS/3, HIRS/4) Flight Model instruments S/N H301 through H307. The HIRS/3, S/N 301, 302, and 303 has a 20KM Field of View. The HIRS/4, S/N 304 through 307 has a 10KM Field of View. An artist's concept of the TIROS spacecraft is illustrated in Figure 1.

Primary infrared calibration will be provided by an onboard blackbody target and space.

2. APPLICABLE DOCUMENTS

The issues of the following documents in effect on the issue date of this specification shall apply to the fabrication and design effort conducted in accordance with the specification, and shall be considered part of this specification. In the event of conflict between this specification and any referenced document, this specification shall govern.

2.1. GSFC AND GENERAL GOVERNMENT SPECIFICATIONS AND STANDARDS

Federal Standard 209: Clean Room and Work Station Requirements, Controlled Environment.

NHB 5300.4(1A): Reliability Program Provisions for Aeronautical and Space Systems Contractors.

NHB 5300.4(1B): Quality Program Provisions for Aeronautical and Space Systems Contractors.

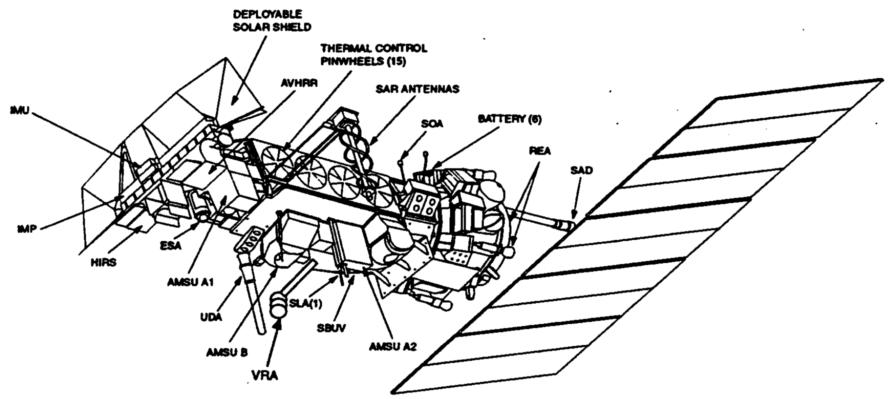
NHB 5300.4(1C) Inspection System Provision for Aeronautical and Space System Materials, Parts, Components and Service.

NHB 5300.4(3A-2): Requirements for Soldered Electrical Connectors.

NHB 5610.1: Handbook for Preparation of Work Breakdown Structure.

GSFC S-250-P-1C: Contractor Prepared Monthly, Periodic, and Final Reports.

GSFC S-311-P-25A: Specification for Electronic Parts Requirement for Tiros-N.



LEGEND	
AMSU	ADVANCED MICROWAVE SOUNDING UNIT
AVHRR	ADVANCED VERY HIGH RESOLUTION RADIOMETER
ESA	EARTH SENSOR ASSEMBLY
HIRS	HIGH RESOLUTION INFRARED SOUNDER
IMP	INSTRUMENT MOUNTING PLATFORM
IMU	INERTIAL MEASUREMENT UNIT
REA	REACTION ENGINE ASSEMBLY
SAD	SOLAR ARRAY DRIVE
SAR	SEARCH AND RESCUE
SBUV	SOLAR BACKSCATTER ULTRAVIOLET SOUNDING SPECTRAL RADIOMETER
SOA	S-BAND OMNI ANTENNA
SLA	SEARCH AND RESCUE TRANSMITTING ANTENNA L-BAND
UDA	ULTRA HIGH FREQUENCY DATA COLLECTION SYSTEM ANTENNA
VRA	VERY HIGH FREQUENCY REALTIME ANTENNA

Figure 1. Artist's Concept of the NOAA-K,L,M,N,N' Spacecraft

GSFC S-312-P-1: Specification for Contractor Malfunction Reporting.

GSFC S-313-100A: Fastener Integrity Requirement

GSFC S-320-G-1: General Environment Test Specification for Spacecraft and Components.

GSFC PPL-18: Preferred Parts List.

GSFC X-600-85-19: METSAT Charged Particle Environment Study, dated November 1985

GSFC X-722-77-14: Alignment Mirror Adhesive Evaluation, dated January, 1977.

GSFC X-764-71-314: A compilation of Low Outgassing Polymeric Materials Normally Recommended for GSFC Cognizant Spacecraft.

MSFC STD-136: Parts Mounting Design Requirements for Soldered Printed Circuit Board Assemblies.

2.2. MILITARY SPECIFICATIONS AND STANDARDS

MIL-STD-130D: Identification Marking for U.S. Government Property.

MIL-STD-461A: Electromagnetic Interference Characteristics, Requirements for.

MIL-STD-462: Electromagnetic Interference Characteristics, Measurement of.

MIL-STD-463: Electromagnetic Interference Technology, Definitions, and System of Units.

DOD-STD-1686: Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment (excluding electrically initiated explosive devices), dated May 2, 1980.

MIL-STD-480: Configuration Control, Engineering Changes, Deviations and Waivers.

MIL-D-5480-E: Data Engineering and Technical Reproduction Requirements.

MIL-M-13508: Reflecting Metallic Surface SCOTCH Tape Adhesion Test.

MIL-M-38510: Microcircuits, General Specification for.

2.3. LM SPECIFICATIONS

IS-3267415: ATN-KLM General Instrument Interface Specification (GIIS), Revision F

IS-2285780: TIROS-N Unique Interface Specification (UIIS) for the High Resolution Infrared Sounder/2 (HIRS/2), Revision N. (This interface specification shall take precedence for spacecraft interface requirements over this specification).

PS-2284374: Performance Specification TIROS Information Processor (TIP).

PS-2284391: Performance Specification Manipulated Information Rate Processor (MIRP).

2.4. ITT DOCUMENT

FINAL REPORT: AVHRR/2 AND HIRS/2I Improvement Study NAS5-29121, Dated July, 1986.

2.5. METOP DOCUMENTS

The following documents will be applicable only to the METOP designated instruments.

MO-IC-MMT-HI-0001: HIRS METOP ICD CCR1618A MOD 177

GSFC S-480-131: Exceptions to the METOP Interface Control Document for the High Resolution Infrared Sounder (HIRS/4) Flight Models H306 and H307, April 2000.

3. <u>OPERATIONAL REQUIREMENTS</u>

3.1. SPACE RADIATION DOSE LEVEL

The expected radiation dose level shall be as defined in GSFC X-600-85-19 METSAT Charged Particle Environment Study, dated November 1985 and updated by Stassinopoulos to Hilton letter subject: Recalculation of Flux and Dose Values for Non-Equatorial Low-Altitude Radiation Environment, dated 5/11/87.

3.2. LIFETIME REQUIREMENTS

3.2.1. <u>Storage Period</u>

The HIRS/3/4 shall be built to operate within specification following storage in a pressurized dry nitrogen shipping/storage container for a <u>Maximum Storage Period of Five Years</u>, except for the HgCdTe detectors.

3.2.2. <u>Storage Temperature</u>

Storage temperature shall be +5^{o} to +25^{o}C for periods exceeding 14 days. For periods less than 14 days, storage temperature shall be +5^{o}C to +30^{o}C.

3.2.3. <u>Pre-Launch Operational Lifetime</u>

The HIRS/3/4 shall be built to operate within specification for the following cumulative period of time from the beginning of storage to launch:

<u>Pre-Launch Cumulative Operational Lifetime</u>: Four months

<u>Orbital Cumulative Operational Lifetime</u>: Three years

3.3. OPERATIONAL HIRS/3/4 BASEPLATE TEMPERATURE

The HIRS/3/4 instrument shall operate within specification for the following temperature range:

<u>Instrument Operational Baseplate Temperature</u>: +10^{o} to +20^{o}C

3.3.1. <u>Ambient Conditions Operational Limitations Warnings</u>

The Contractor shall identify and document warnings in the instrument <u>Alignment and Calibration Handbook</u> and by letter to the GSFC Technical Officer regarding all sensitive parts, materials and components and operational instrument limitations. Such a warning might be a maximum recommended time for ambient temperature operation of normally-cooled detectors.

3.4. NOMINAL ORBITAL PARAMETERS

Orbit altitude: 833 $\pm$92KM (450 $\pm$50 nmi) circular

Orbit radius: 7,211KM

Orbit period: 102 minutes

Nodal Regression: 25.4 degrees/orbit w

Sun-synchronous inclination: 98.8 degrees

Nodes: 0600 to 1000, local time, descending node or
1300 to 1800, ascending node

3.4.1 Sun Angle

The HIRS/3/4 instrument, with the exception of the radiant cooler, shall be designed to operate within specification when exposed to any sun angle from 0^o to $+80^o$. The radiant cooler shall operate within specification when exposed to any sun angle from 0^o to $+68^o$. The spacecraft will provide solar shielding for solar angles between $+68^o$ to $+80^o$ similar to that provided on NOAA-I. The sun angle is defined as the angle between the satellite-to-sun line and the normal to the orbital plane, with the spacecraft in normal operating orientation.

3.5. OPERATIONAL MODES

3.5.1. Launch Phase and Orbital Acquisition Modes

During these modes, the HIRS/3/4 will be unpowered except for the scan motor and filter wheel motor.

3.5.2. Orbital Modes

The mission mode is defined as the normal operating mode of the HIRS/3/4. The standby mode is defined as the unpowered mode of the HIRS/3/4.

4. TECHNICAL REQUIREMENTS

4.1. FUNCTIONAL REQUIREMENTS

4.1.1. General

The HIRS/3/4 flight models shall be discrete stepping, line-scan instruments designed to measure scene radiance in 20 spectral bands to permit the calculation of the vertical temperature profile from the Earth's surface to about 40KM. It shall have:

HIRS/3	20KM and
HIRS/4	10KM

resolution at nadir when in nominal orbit.

The radiometer shall consist of an optical system, detectors, associated electronics, scanner and radiative cooler, all housed in one package which will be mounted on the TIROS instrument mounting platform (IMP).

4.1.2 Scan System

The HIRS/3/4 is a scanning radiometer. It shall have a nominal Field of View of:

HIRS/3	1.40^{o} and
HIRS/4	0.69^{o}

at the 50 percent power points.

The mirror is stepped transverse to the suborbital track in increments of 1.8^{o} between $+49.5^{o}$ for a total of fifty-six scan elements per line. The spacecraft orbital motion provides the forward dimension to the scan pattern. Figure 2 shows the required scan pattern projected onto the Earth. The mirror shall dwell at each FOV for 100ms, including step and settle times. Up to 800 ms is allowed to retrace to the starting position. Total scan line time including retrace is 6.4 seconds.

4.1.3. In-Flight Radiometric Calibration

The HIRS/3/4 must provide a method for periodically checking the calibration of the radiometer while in orbit. The in-flight calibration will be implemented by command or automatic sequence to cause the radiometer to view radiation from one internal housing blackbody, designated the Internal Warm Target, whose temperature shall be monitored to an accuracy of better than 0.1^{o} with a goal of 0.05^{o}C, and from space. Each housing radiance shall be sampled 56 times per channel during each calibration period, and space shall be sampled 48 times per channel using the same timing and integration periods for each spectral filter which are normally used for measurements of the Earth radiances. The Internal Cold Target view must still be available but not part of the Autocal sequence. It must be commanded separately.

4.1.4. Clock Signals

The HIRS/3/4 shall be provided with a 1.248 MHZ clock and a 1 Hz clock by the spacecraft for timing purposes. All frequencies used shall be derived from these clock signals. See the TIROS-N Unique Interface Specification (HIRS/3/4 UIIS) for additional information.

4.1.5. Test Points

Test points shall be provided in the HIRS/3/4 to facilitate initial testing to ensure conformance with the system specification. During final acceptance and calibration tests all test points/connectors shall be stowed as they would be in orbit.

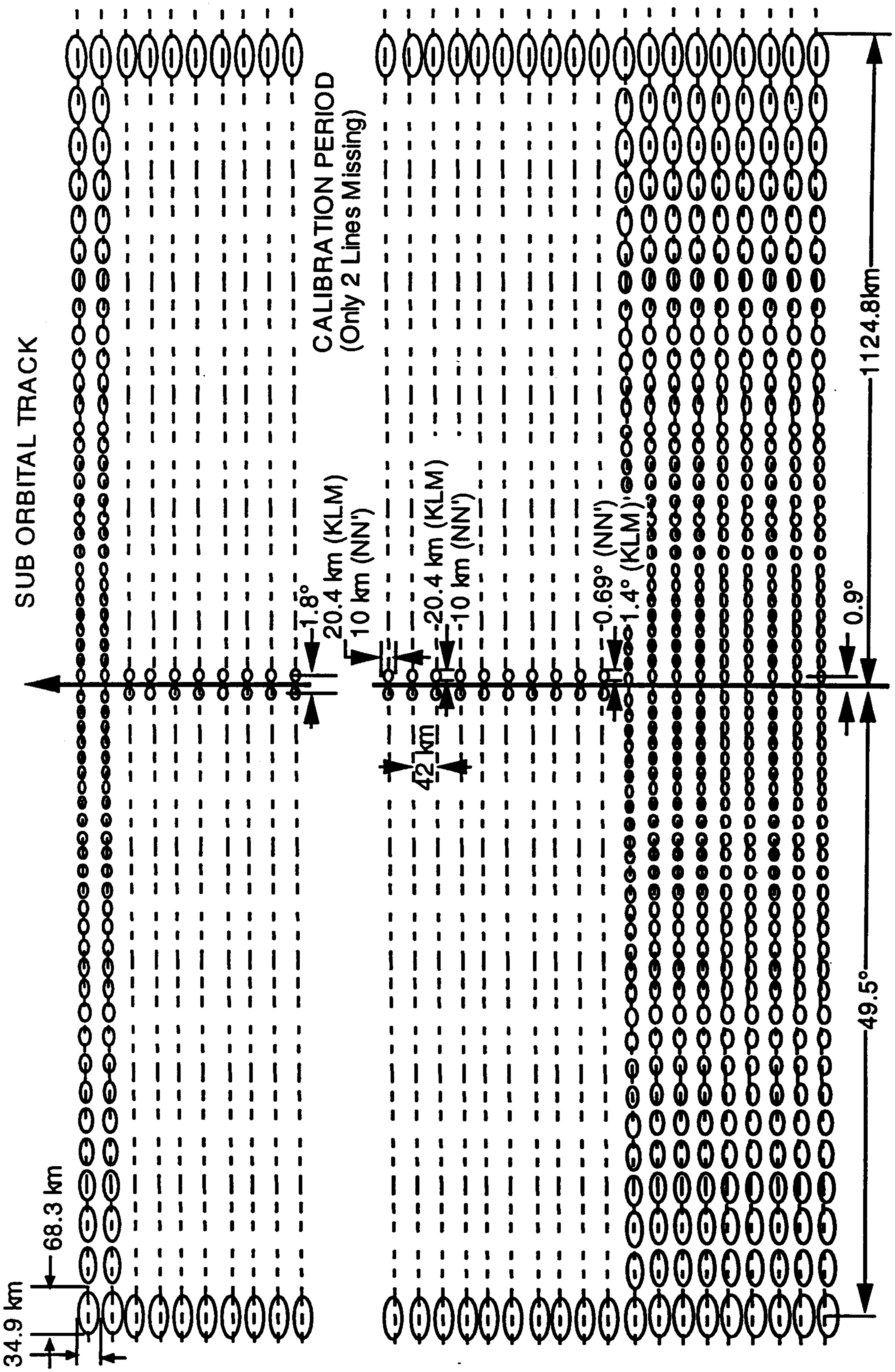


Figure 2. HIRS/3/4 Scan Pattern Projected on Earth

4.2. SYSTEM PERFORMANCE REQUIREMENTS

4.2.1. General

The HIRS/3/4 shall be designed to meet the requirements as stated in the following sections. In some cases, design goals are given and are specifically identified as such. Absence of such designation indicates a mandatory requirement. While design goals are not mandatory requirements, their attainment will materially improve scientific value of the data and, in turn, the operational product. The contractor shall attempt to meet all design goals which prove to be practical within the design and budget constraints.

4.2.2. Spectral Intervals

The HIRS/3/4 shall measure scene radiances in 20 spectral bands. These spectral bands shall have the characteristics specified in Table 1.

4.2.3. Dynamic Range

The HIRS/3/4 shall be capable of measuring scene radiances over the temperature range 4^{o} to 305^{o}K except for the window channels (i.e., channels 8 and 17 which must respond to targets as warm as 330^{o}K and channels 18 and 19 which must respond to targets as warm as 340^{o}K).

4.2.4. Noise Equivalent Spectral Radiance (NEdN)

The HIRS/3/4 shall be designed to meet the required NEdN as specified in Table 2.

4.2.5. Relative Accuracy

4.2.5.1. Systematic

The standard deviation of 50 or more samples of radiometric data taken when viewing an external reference target or the internal calibration target for any spectral band shall be equal to or less than the required (NEdN) for that band.

4.2.5.2. Correction for Temperature Effects

The instrument shall be built so that its spectral radiance measurements can be corrected for variation in calibration induced by changes in instrument ambient conditions. The dependence of instrument calibration on the temperature of the critical elements of the system, including primary optics, secondary optics, filter housing, instrument baseplate, etc., shall be available from data taken during preflight calibration measurements by the instrument contractor. All elements that change response to a given target radiance shall be monitored and data telemetered.

4.2.6. Absolute Accuracy

The reference sources used as targets for preflight calibration shall have temperature sensors calibrated to not less than secondary standards traceable to the NIST.

4.2.7. Memory Error

The output signal presented to the A/D converter for each spectral interval shall be independent of past signals in that channel and signals in other channels. The outputs of each spectral interval shall not be in error by more than that specified due to the effects of any combination of previous signals.

Table 1

Bandpass Filters for HIRS/3/4

CH No.	Center Frequency (cm^{-1})	Half Bandwidth (cm^{-1})	1% Abs Transm'n Max BW (cm^{-1})	0.1% Absolute Transmission Max BW	Min Peak Transm'n	HBW Cntrng Tolerance (cm^{-1})
1	668.5±1.3	3.0 +1/-0.5	20	12.0xHBW	30%	±0.5
2	680.0±1.8	10 +4/-1	40	4.5xHBW	50%	±1
3	690.0±1.8	12 +6/-0	40	4.5xHBW	55%	±1
4	703.0±1.8	16 +4/-2	40	4.5xHBW	55%	±1
5	716.0±1.8	16 +4/-2	40	4.0xHBW	55%	±1
6	733.0±1.8	16 +4/-2	40	4.0xHBW	55%	±1
7	749.0±1.8	16 +4/-2	40	4.0xHBW	55%	±1
8	900.0±2.7	35±5	90	3.0xHBW	55%	±4
9	1030.0±4	25±3	75	4.0xHBW	50%	±4
10	802.0±2	16 +4/-2	40	4.0xHBW	55%	±1
11	1365.0±5	40±5	120	4.0xHBW	50%	±4
12	1533.0+2/-6	55±5	120	3.0xHBW	60%	±5
13	2188.0±4.4	23±3	60	3.6xHBW	35%*	±2
14	2210.0±4.4	23±3	60	3.6xHBW	35%*	±2
15	2235.0±4.4	23±3	60	3.6xHBW	35%*	±2
16	2245.0±4.4	23±3	60	3.6xHBW	35%*	±2
17	2420.0±4	28±3	75**	3.6xHBW	35%*	±2
18	2515.0±5	35±5	105	3.6xHBW	40%	±2
19	2660.0±9.5	100±15	300	3.6xHBW	50%	±5
20	14500±220	1000±150	N/A	N/A	70%	N/A

*Filter is acceptable only if product of HBW x PEAK TRANSMISSION ≥ 9.0 cm^{-1}.
**Transmission at 2390 cm^{-1} to be equal to or less than 5%.

Table 2

HIRS/3/4 Spectral Requirements

Channel	Channel Frequency (cm^{-1})	micron	Half Power Bandwidth (cm^{-1})	Anticipated Max. Scene Temp(^oK)	Specified NEdN	Design Goal
1	669	14.95	3	280	3.00	.75
2	680	14.71	10	265	0.67	.25
3	690	14.49	12	240	0.50	.25
4	703	14.22	16	250	0.31	.20
5	716	13.97	16	265	0.21	.20
6	733	13.64	16	280	0.24	.20
7	749	13.35	16	290	0.20	.20
8	900	11.11	35	330	0.10	.10
9	1,030	9.71	25	270	0.15	.15
10	802	12.47	16	300	0.15	.10
11	1,365	7.33	40	275	0.20	.20
12	1,533	6.52	55	255	0.20	.07
13	2,188	4.57	23	300	0.006	.002
14	2,210	4.52	23	290	0.003	.002
15	2,235	4.47	23	280	0.004	.002
16	2,245	4.45	23	270	0.004	.002
17	2,420	4.13	28	330	0.002	.002
18	2,515	4.00	35	340	0.002	.002
19	2,660	3.76	100	340	0.001	.001
20	14,500	0.69	1000	100% A	0.10% A	----

NEdN in mW/m2 ST cm^{-1}

5. ELECTRICAL REQUIREMENTS

5.1. GENERAL

The output signal of the detector will be processed in a minimum number of analog signal channels consisting of an amplifier, processor, and an integrator. The integrated radiation signals and analog temperature and voltage monitoring signals required to reduce the instrument data will be sampled in various specified single bit command and status, and 13-bit data words. The digitized data and various single bit command and status monitors will be formatted and fed to the spacecraft TIP. The scan program and other functions shall be synchronously timed with the data processing and the spacecraft clock. Certain command functions, temperatures, and status monitoring data will be supplied to the spacecraft via the analog and Digital B route of TIP.

5.1.1. Printed Circuits

All electronic new or changed circuit designs and their printed circuit board layouts shall be optimized for reliability and shall employ good engineering practices. The contractor shall document this effort in a separate section of the Technical Description Document due at the end of his design phase.

5.1.2. Electronic Parts

Parts previously approved on NAS 5-30384 (NOAA-K,L & M program) are approved for use on this program. Where new or different parts are necessary or desirable, they shall be selected from PPL-18, Preferred Parts List, Grade 1 Parts, if possible. Otherwise, approval for use shall be by Nonstandard Part Approval Request (NSPAR). Previously approved non-grade 1 parts, which were not on a Preferred Parts List (PPL), shall be identified only; no new NSPAR will be required for them.

5.2. ANALOG ELECTRONICS

5.2.1. Gain Stability

The measurement of non-systematic random errors affecting radiometer response, when viewing a stabilized target at a given temperature, shall be reproducible to within 1 NEdN over the instrument baseplate temperature range of $+5^{o}C$ to $+25^{o}C$. Because of the potential contamination due to cooler outgassing, any such check of radiometer stability shall be made shortly after an instrument decontamination cycle.

5.2.2. Linearity

The nonlinearity of the electronic chain (preamplifier through integrator) shall not exceed 0.1 percent of the full scale signal at any given temperature in the range $+5^{o}C$ to $+25^{o}C$. The gain stability of the visible channel over the range from $+5^{o}C$ to $+25^{o}C$ shall not exceed 0.5 percent.

5.2.3. Drift

The drift in the reference level from scan line to scan line shall not exceed 1 NEdN. An average of at least 48 samples of data taken at a fixed-source temperature shall be used for comparison of successive scan line times.

5.2.4. Electronic Calibration

A system for calibrating and/or checking the linearity of the electronics shall be incorporated; for example, an electronic stair case can be inserted at the earliest possible stage in the electronic chain.

5.3. ANALOG TO DIGITAL ELECTRONICS

5.3.1. General

The analog to digital subsystem shall consist of a multiplexer and a thirteen bit A/D converter.

5.3.2. Multiplexer

The multiplexer shall not introduce a voltage offset or other errors sufficient to degrade the overall A/D conversion accuracy beyond 0.01 percent of full scale.

5.3.3. Analog to Digital Converter

The accuracy of the A/D converter at 15°C Instrument Baseplate temperature shall be $\pm$1/2 LSB maximum allowable error. In addition, the differential nonlinearity (the bit-to-bit variation) shall not exceed $\pm$1/2 bit. Over the temperature range of -5°C to +25°C Instrument Baseplate temperature the maximum allowable error shall not exceed $\pm$1 LSB.

A discontinuity at the zero crossing point may occur due to the tailoring of the sign bit comparator circuitry. The discontinuity shall not produce an error greater than 2 counts at the zero crossing.

5.3.4. Independence of Measurements of Each Channel

The output signal presented to the A/D for each spectral interval shall be independent of past signals in that channel and signals in other channels. The outputs of each spectral interval shall not be in error by more than 0.1 percent (of full scale) because of any previous signals in that channel or crosstalk from other channels when scanning in either direction and on successive steps.

5.4. PHASE REFERENCE PICKUP (PRP) AND ENCODER SIGNALS

Redundancy of components and/or assemblies is required for the PRP sensors.

5.5. POWER SYSTEM

5.5.1. General

The HIRS/3/4 subsystem power supply shall provide all power needed to operate the system except as noted. The system will operate from the spacecraft +28 V power system, which will be supplied to the instrument in the form of a fused +28 V main bus, a switched +28 V analog telemetry bus, and a +28 V pulse load bus which shall be used for powering stepper motors, heaters, and other high current pulse loads which cannot meet the main bus current ripple requirements. Those subsystems that are powered from the pulse load bus need not be isolated by a dc/dc converter. They will require adequate power line filtering to prevent high level noise on this bus from affecting the operation of the HIRS/3/4 instrument.

A +10 V bus is available for powering CMOS-to-CMOS interface circuits. This circuit provides power for interfaces for commands, clocks, synchronization pulses, digital data pulses and levels, and data transfer windows. No dc/dc converter is required in this interface circuit.

Further information regarding the spacecraft power sources is contained in the TIROS-N General Instrument Interface Specification (GIIS).

5.6. POWER CONVERTERS

All dc/dc converters within the HIRS/3/4 shall be coherent with the spacecraft clock (at the same frequency or any subharmonic frequency of the spacecraft clock). In the event that more than one dc/dc converter is utilized, one shall be designated as the prime converter and synchronized to the spacecraft clock. The others shall be synchronized to the prime converter to eliminate intra-instrument beat frequencies. The converters shall operate at frequencies which are integral multiples of any synchronized with the scan rate. If more than one dc/dc converter is required, they shall operate at frequencies which will prevent the introduction of undesirable beat frequencies in the passband of the radiometer.

5.6.1. Orbital Average Power

The total orbital average power usage of the HIRS/3/4 shall not exceed 25W.

5.6.2. Power Conversion EMI

Power converter frequencies shall be selected which will place harmonics outside of the Search and Rescue frequency band of 121.5 MHZ $\pm$12.5 kHz.

5.6.3. HIRS/3/4 Operating Characteristics

The HIRS/3/4 shall display the following operating characteristics:

5.6.3.1. Normal Operation/Input Voltage Range The HIRS/3/4 shall perform within specification when operated from the main power bus even if the voltage on that bus should vary from +26 V to +30.

5.6.3.2. Over Voltage Protection The HIRS/3/4 shall withstand a continuous over voltage on the +28 V main power bus of +38 V dc without damage. Under these conditions, components shall not be stressed beyond their specified maximum ratings (including the effect of environment). The HIRS/3/4 shall be operating within specification within three minutes after the over voltage is removed.

5.6.3.3. Transient Load Currents Surge currents drawn by the HIRS/3/4 at switch-on shall not exceed 3 A peak. Steady state conditions shall be attained within 1 second from the start of the transient. The rate of change of current during the switch-on transients shall not exceed 20 ma/microsecond except under the bus fault conditions. See the TIROS-N GIIS for additional information.

5.6.3.4. Feedback Ripple or Noise The peak-to-peak amplitude of steady state load current ripple generated by the instrument shall not exceed 2 percent of the maximum average steady state current. The fundamental frequency of the load current ripple shall not exceed 30 kHz. The rate of change of current shall in no case exceed 20 ma/microsecond, except during main bus fault conditions.

5.6.3.5. Input Configuration Two pins in parallel shall be used for both the regulated power input and return. One input and one return line shall be routed to the connector. The regulated power return shall not be connected to the case ground of the HIRS/3/4 and all input leads shall be isolated from the case by at least 10 Megohms.

5.6.3.6. Fusing There shall be no fuses internal to the unit. Fusing will be supplied by the spacecraft power system. The contractor shall, however, provide cooler outgas heater fuses in the body of the J9 Test Connector mating connector which will fly with the instrument.

5.6.3.7. Power Separate power lines shall be provided from the spacecraft +28 V pulse supply to the control relays for powering the scan system and other circuitry as required. A separate power line from the +28 V main power bus will provide voltage for the electronics system. Peak power from main and pulse supplies shall be equal to or less than that required by the HIRS/3/4.

5.6.3.8. Input filter An input filter shall be connected to the +10 V bus. See the TIROS-N GIIS, for additional information.

5.7. HIRS/3/4 CLOCK AND COMMAND REQUIREMENTS

5.7.1. Clocks

The HIRS/3/4 spacecraft interfaces shall be synchronous with reference to the clocks furnished from the spacecraft. The contractor has the use of a 1.248 MHZ and a 1 Hz clock. One or both of these clocks shall be used to generate all interface timing. The clock waveforms from the spacecraft will conform to the TIROS-N GIIS.

5.7.2. Commands

The commands circuitry accepts the various commands from the spacecraft and operates through logic or relays the various functions needed for the HIRS/3/4 instrument. It should be noted that there are two types of commands. The first is a level discrete type. This type of command presents an "on" or "true" condition to the instrument full time; for example, another command must be issued to turn it off. The second type is a pulse discrete where an "on" or "true" condition is issued in the form of a pulse. The pulse varies in duration from 0.5 sec to 1.5 seconds.

A listing of commands and their descriptions and effects on the HIRS/3/4 instrument is given in Table 3. The contractor shall specify the type of command required (bilevel or pulse) and add any necessary commands not included.

5.8. DATA SYSTEM

5.8.1. General

The data system for the HIRS/3/4 shall consist of circuitry needed to output all of the IR channels, temperature and voltage monitors, and general status information. All of this information shall be fed out and controlled by the spacecraft TIP. The HIRS/3/4 data system shall be built to utilize the TIP digital A, digital B and subcommutated analog channels and the spacecraft analog telemetry bus as specified below. A complete interface description of the spacecraft telemetry system can be found in the General Instrument Interface Specification.

5.8.2. Digital A

The HIRS/3/4 shall be built to output all digital instrument data to the TIP digital A data channels. These data shall include all radiometric signals, sync words, instrument temperatures, encoder position and any other information required for utilization of the radiometric data. The digital A format is based upon the 100 ms minor frame (1 HIRS/3/4 scan step).

5.8.2.1. Data Output Requirements The HIRS/3/4 digital data rate shall be 2880 bps, and data shall be read out sequentially at the TIP interrogation rate. Each minor frame shall contain 260 bits of radiometric data (20 channels x 13 bits) and 28 bits of other digitized data. Each HIRS/3/4 scan line shall contain 64 minor frames of data, 56 corresponding to the 56 scan steps and 8 comprising the 800 ms allotted for retrace. The 8 retrace minor frames will not contain radiometric data but will be utilized for other required data that cannot be included in the first 56 minor frames. However, the format of each scan line shall be identical except for the first line of calibration. During a calibration sequence, the scan mirror will move during the 800 ms allowed for retrace, and it will acquire 56 minor frames of radiometric data from the internal target just as if it were scanning. Since the scan mirror must return to scan step zero before a calibration sequence can be started, the first 8 minor frames of data of the first calibration line will be retrace data followed by 48 minor frames of radiometric data from space and the final 8 minor frames of retrace data. The 800 ms reduction in the space calibration time is required for the scan mirror to move from scan step zero to the space position.

Table 3

HIRS/3/4 Commands

No.	Command	Description
1	Instrument ON	This command connects both the +28 electronics bus and pulse bus to HIRS/3/4 and energizes the dc/dc converter, permitting subcom analog temperature monitoring in the absence of all other power.
2	Instrument OFF	Disconnects all +28 V buses from the instrument except +28V bus for commands and full time +28V telemetry bus. It returns all other commands to OFF or disabled condition.
3	Scan Motor ON	Provides power to the scan motor. When used with electronics off, it drives scan motor in a continuous stepping mode. This feature is used during launch to prevent damage to motor bearings
4	Scan Motor OFF	Command scan motor off.
5	Filter Wheel Motor ON	Provides power to the Filter Wheel drive motor. Permits filter wheel operation near synchronous speed when electronics power is off.
6	Filter Wheel Motor OFF	Commands filter wheel motor off.
7	Electronics ON	Provides power to all remaining electronic and data handling systems.
8	Electronics OFF	Commands electronics power off.
9	Cooler Heat ON	Provides power to first and second stage cooler heaters. Used during orbital decontamination.
10	Cooler Heat OFF	Commands cooler heater power off.
11	Internal Warm Target (IWT) Position	When the instrument is in the calibration enable mode, this command causes the scan mirror to move to the internal warm target after completion of the current scan line and retrace to step zero. The scan mirror will remain at the IWT until this command is disabled.
12	Internal Cold Target	This command causes the scan mirror to move to (ICT) the internal cold target, but is not part of the Position calibration enable sequence. The Calibration Disable command must be sent first. The mirror will remain viewing the Internal Cold Target until this command is disabled.

Table 3 (continued)

HIRS/3/4 Commands

No.	Command	Description
13	Space Position	When the instrument is in the calibration enable mode, this command causes the scan mirror to move to space after completion of the current scan line and retrace to step zero. The scan mirror will remain at space until this command is disabled.
14	Nadir Position	When the instrument is in the calibration enable mode, this command causes the scan mirror to move to nadir after completion of the current scan line and retrace to step zero. The scan mirror will remain at nadir until this command is disabled.
15	Position Disable	Disables the IWT, ICT, Space and Nadir position commands and returns scan mirror to scan step 0. Scan will resume upon receipt of next line sync (first element) pulse.
16	Calibration Enable	Enables the radiometric calibration control logic. When sent, the scanner will continue line scanning until the next major frame sync pulse. It will then execute a normal calibration sequence. Subsequent calibration sequence will be executed upon receipt of a Calibration Start Pulse coincident with major frame sync.
17	Calibration Disable	Disable the instrument calibration mode. In this mode the instrument will ignore the spacecraft calibration start pulse.
18	Cover Release Enable	Provide power to the Earth shield release solenoid drive circuit only after Instrument Power is ON.
19	Cover Release Disable	Reset the Cover Release Enable relay to the OFF position.

Table 3 (continued)

HIRS/3/4 Commands

The following commands will not be affected by the INSTRUMENT OFF command.

No.	Command	Description
20	Cooler Cover	Commands opening of cooler door by applying a two second pulse to the cover release solenoid. Operates only if Instrument Power ON and Cover Release Enable commands are sent.
21	Filter Housing Heat ON	Provides power to filter housing heaters and automatic temperature control circuitry.
22	Filter Housing Heat OFF	Commands filter housing heat off.
23	Patch Temp. Control ON	Provides power to patch temperature control heater to control patch at approximately 105K.
24	Patch Temp. Control OFF	Commands patch temp. heater off permitting patch to seek equilibrium temperature.
25	Filter Motor Normal Power	Applies preset power level to filter wheel motor for normal operation
26	Filter Motor High Power	Applies maximum power to filter wheel motor for cold operation and end of life conditions.

5.8.2.2. Minor Frame Data Format (Digital A) Each minor frame shall consist of an 18 x 16 bit array (36, 8 bit words in TIP). The data format for each minor frame is shown in Table 4.

5.8.3. Digital B

The digital B or bilevel telemetry consists of single bit status monitors used essentially for command verification. The sample rate of each allotted bilevel channel will be once every 3.2 sec. Table 5 lists the Digital B output.

5.8.4. Subcommutated Analog Telemetry

These telemetry channels are intended for instrument use to monitor critical parameters used for determination of correct instrument operation and for diagnostic purposes. These circuits shall be powered from the instrument dc/dc converter. TIP contains three subcommutated frames for sampling low rate analog data. A 1 sample/32 sec, 1 sample/16 sec and 1 sample/sec subcom is provided; up to 35 analog telemetry channels will be provided for use by the HIRS/3/4. Analog telemetry output and sample rates are listed in Table 5.

5.8.5. Analog Housekeeping Telemetry

The spacecraft provides a separate switched +28 V bus to each instrument for monitoring housekeeping temperatures when the instrument is off. This full time Analog Housekeeping Telemetry is given in Table 5.

5.8.6. Test Points

The contractor shall provide test points for engineering evaluation and ground level system checkout as required. All test point interface requirements are given in the General Instrument Interface Specification. Test points shall be stowed and no connections made to them during all flight acceptance testing and calibration.

5.9. SYNCHRONIZATION PULSES

TIP will provide the HIRS/3/4 with a major frame synchronization pulse once every 32 sec, and a calibration start pulse at the beginning of every ninth major frame (every 256 sec). This calibration pulse shall occur within 1 microsecond of the negative going edge of the major frame pulse and, provided calibration has been enabled, the HIRS/3/4 will enter a calibration sequence upon completion of scan step 55. The HIRS/3/4 shall utilize the major frame sync pulse to synchronize the complete system including the scan and filter wheel drives.

Table 4

HIRS/3/4 Digital A Data Output

Element 0-55

Bit 1-8	Encoder Position
Bit 9-13	Electronic Cal Level
Bit 14-19	Channel 1 Period Monitor
Bit 20-25	Element Number
Bit 26	Filter Sync Designator
Bit 27-286	Radiant Signal Output (20Ch x 13 Bits)
Bit 287	Valid Data Bit
Bit 288	Minor Word Parity Check

Element 56-63

Bit 1-26	Same as Above
Bit 287, 288	Same as Above

Element 56

Bit 27-286	Positive Electronic Cal. (Cal Level Advances one of 32 Equal Levels on Succeeding Scans)

Element 57

Bit 27-286	Negative Electronic Cal.

Element 58

Bit 27-91	Internal Warm Target #1, 5 Times
Bit 92-156	Internal Warm Target #2, 5 Times
Bit 157-221	Internal Warm Target #3, 5 Times
Bit 222-286	Internal Warm Target #4, 5 Times

Element 59 HIRS/3

Bit 27-91	Internal Cold Target #1, 5 Times
Bit 92-156	Internal Cold Target #2, 5 Times
Bit 157-221	Internal Cold Target #3, 5 Times
Bit 222-286	Internal Cold Target #4, 5 Times

Element 59 HIRS/4

Bit 27-91	Internal Cold Target #1, 5 Times
Bit 92-156	Ground
Bit 157-221	Internal Warm Target #5, 5 Times
Bit 222-286	Primary Baffle Temp, 5 Times

Table 4 (continued)
HIRS/3/4 Digital A Data Output

Element 60

Bit 27-91	Filter Housing Temp. #1, 5 Times
Bit 92-156	Filter Housing Temp. #2, 5 Times
Bit 157-221	Filter Housing Temp. #3, 5 Times
Bit 222-286	Filter Housing Temp. #4, 5 Times

Element 61

Bit 27-91	Patch Temp. Expanded, 5 Times
Bit 92-156	First-stage Temp., 5 Times
Bit 157-221	Filter Housing Control Power/Temp., 5 Times
Bit 222-286	Electronic Cal DAC, 5 Times

Element 62

Bit 27-39	Scan Mirror Temp.
Bit 40-52	Primary Telescope Temp.
Bit 53-65	Secondary Telescope Temp.
Bit 66-78	Baseplate Temp.
Bit 79-91	Electronics Temp.
Bit 92-104	Patch Temp.-Full Range
Bit 105-117	Scan Motor Temp.
Bit 118-130	Filter Motor Temp.
Bit 131-143	Cooler Housing Temp.
Bit 144-156	Patch Control Power
Bit 157-169	Scan Motor Current
Bit 170-182	Filter Motor Current
Bit 183-195	+15 Vdc
Bit 196-208	-15 Vdc
Bit 209-221	+7.5 Vdc
Bit 222-234	-7.5 Vdc
Bit 235-247	+10 Vdc
Bit 248-260	+5 Vdc
Bit 261-273	Analog Ground
Bit 274-286	Analog Ground

Element 63

Bit 27-39	Line Count
Bit 40-41	Fill Zeros
Bit 42-44	Instrument S/N
*Bit 45-52	Command Status
Bit 53-57	Fill Zeros
*Bit 58-65	Command Status
Bit 66-78	Binary Code (1,1,1,1,1,0,0,1,0,0,0,1,1) +3875 (Base 10)
Bit 79-91	+1443
Bit 92-104	-1522

Table 4 (Continued)
HIRS/3/4 Digital A Data Output

Element 63 (continued)

Bit 105-117		-1882
Bit 118-130		-1631
Bit 131-143		-1141
Bit 144-156		+1125
Bit 157-169		+3655
Bit 170-182		-2886
Bit 183-195		-3044
Bit 196-208		-3764
Bit 209-221		-3262
Bit 222-234		-2283
Bit 235-247		-2251
Bit 248-260		+3214
Bit 261-273		+1676
Bit 274-286		+1992
*Bit 45	Instrument ON/OFF	ON = 1
*Bit 46	Scan Motor ON/OFF	ON = 0
*Bit 47	Filter Wheel ON/OFF	ON = 0
*Bit 48	Electronics ON/OFF	ON = 1
*Bit 49	Cooler Heat ON/OFF	ON = 0
*Bit 50	Internal Warm Target Pos	True = 0
*Bit 51	Internal Cold Target Pos	True = 0
*Bit 52	Space Position.	True = 0
*Bit 58	Nadir Position.	True = 0
*Bit 59	Calibration Enable/Disable	Enabled = 0
*Bit 60	Cover Release Enable/Disable	Enabled = 0
*Bit 61	Cooler Cover Open	Yes = 1
*Bit 62	Cooler Cover Closed	Yes = 1
*Bit 63	Filter Housing Heat ON/OFF	ON = 0
*Bit 64	Patch Temp. Control ON/OFF	ON = 0
*Bit 65	Filter Motor Power HIGH	Normal = 1

*Command Status Bits

Table 5

Telemetry

	Digital A	Subcommutated Analog	Sample Rate
Scan Mirror Temp	X		
Primary Mirror Temp	X		
Secondary Mirror Temp	X		
Radiator Temp	X	X, 6	32
Baseplate Temp	X		
Electronics Temp	X	X, 22	32
Patch Temp Full	X	X, 231	32
Patch Expanded Temp	X		
Scan Motor Temp	X		
Filter Motor Temp	X	X, 246	32
Filter Hsg Temp #1	X		
#2	X		
#3	X		
#4	X		
Filter Hsg Current	X	X, 285	32
Warm Tgt Temp #1	X		
#2	X		
#3	X		
#4	X		
Cooler Hsg Temp	X		
Cold Tgt Temp #1	X		
Cold Tgt Temp #2	X(HIRS/3)		
Cold Tgt Temp #3	X(HIRS/3)		
Cold Tgt Temp #4	X(HIRS/3)		
Cold Tgt Temp #2	Not USED (HIRS/4)		
Warm Tgt Temp #5	X(HIRS/4)		
Primary Baffle Temp	X(HIRS/4)		
Channel 1 Period	X		
Patch Control Pwr	X	X, 255	32
+15 VDC TLM		X, 366	16
-15 VDC TLM		X, 271	16
+5 VDC TLM		X, 301	16
+15 VDC	X		
-15 VDC	X		
+10 VDC	X		
+5 VDC	X		
+7.5 VDC	X		
-7.5 VDC	X		
+10 VDC TLM		X, 334	16
-7.5 VDC TLM		X, 359	16
+7.5 VDC TLM		X, 342	16
Scan Mtr Current	X	X, 245	32
Filter Wheel Mtr Current	X	X, 261	16
Cal Step Voltage	X		

Table 5 (continued)

Telemetry

Digital B Telemetry	0V (Logic 1) / +5V (Logic 0)
Instrument Power	ON/OFF
Electronics Power	ON/OFF
Filter Motor Power	ON/OFF
Scan Motor Power	ON/OFF
Cooler Heater	ON/OFF
Filter Housing Heater	ON/OFF
Cooler Cover Release	ENABLE/DISABLE
Window Heater	OFF/ON
Nadir Position	YES/NO
Calibration Sequence	ENABLE/DISABLE
Cooler Cover Closed	NO/YES
Cooler Cover Open	NO/YES
Filter Motor Power	HIGH/NORMAL
Patch Temperature Control	ON/OFF

Full Time Telemetry	Sample Rate
Baseplate Temperature	32, 14
Scan Motor Temperature	32, 239

5.10. CONTROL LOGIC

5.10.1. General

The control logic shall generate all timing and control signals needed to operate the motors, power supply, A/D system, scan logic control; and accept the TIP control pulses to output the HIRS/3/4 data. The control logic must initiate the sample-and-convert cycle which will cause a complete set of data to be sampled, converted and outputted each time a channel, temperature monitor, or voltage monitor is sampled. The control logic will control scan and be capable of accepting external commands from the spacecraft and responding to these commands.

5.10.2. Scan Control

5.10.2.1. General The scan control shall be built to fulfill the requirements for continuous, full-time coverage. Movement of the scan mirror, the filter wheel, and integration of the IR and visible channels shall all be synchronized.

The stepping of the scan mirror and the signal integration period shall be timed to complete the spectral sampling and mirror step and settling within the 100 ms specified for each FOV. Each scan line including retrace shall be completed within 6.4 sec.

5.10.2.2. Scan Control Commands The ELECTRONICS ON command controls all logic functions of the HIRS/3/4. All functions applicable to operation in the mission mode are controlled by the specific command when used in conjunction with this command. Apart from the exceptions noted below, no command will be accepted by the HIRS/3/4 unless the ELECTRONICS ON command has been previously sent. In addition, this command, when sent, will automatically disable all calibration control logic.

5.10.2.2.1. The ELECTRONICS OFF Command overrides all scan control commands except where noted and disables all systems logic functions. Upon its receipt by the HIRS/3/4, the filter wheel motor will continue in near synchronous operation, and the scan system will continue in the launch phase mode if both are on.

5.10.2.2.2. The SCAN MOTOR ON Command turns on the scan motor and when used with the electronics unpowered, the scan system enters the launch phase mode of operation. In this mode, the scan mirror is stepped continuously through a 360^{o} rotation in 1.8^{o} increments. There shall be no retrace in this mode. When used with the electronics powered (the Electronics On Command can be sent first or second), the scan system will operate in the normal mission mode. The scan logic will first position the scan mirror in scan step zero. Upon receipt of the next major frame sync pulse, the scan system shall begin normal scanning and data processing will begin.

5.10.2.2.3. When SCAN MOTOR OFF Command is sent, the mirror will stop and rest where it is at the time of the sending of the command. The scan off command shall override any other scan control commands except scan on. If the electronics remains powered, the HIRS/3/4 will continue to process data, provided the filter wheel motor is on.

5.10.2.2.4. The CALIBRATION ENABLE Command enables the calibration control logic provided the instrument is operating in the mission mode, i.e., the Electronics On and Scan Motor On commands must have been sent previously. Otherwise the command shall be ignored by the HIRS/3/4. When the Calibration Enable command is sent, unless previously sent, the HIRS/3/4 will enter a normal calibration sequence upon completion of the present line scan and retrace to the step zero position. If the instrument is at scan step zero awaiting a major frame sync pulse, a normal calibration sequence shall be initiated immediately. All calibration sequences shall start from the scan step zero position. When the calibration control logic is enabled, the scan system will enter a normal calibration sequence upon receipt of the 256 second calibration start pulse. All calibration control logic will be disabled upon receipt of a subsequent ELECTRONICS ON Command.

5.10.2.3. Verification of Scan Angular Positions The scan mirror position shall be read out as a digital word to verify each discrete position. The encoder used shall be designed to give unique position readout anywhere within the 360^o.

5.11. TEMPERATURE CONTROL AND MEASUREMENT

5.11.1. Temperature Control Requirements

All temperature controllers used during orbit operation shall be of the continuous, proportional type. The heater and other controller currents shall be well filtered. The operation of the controllers shall not interfere with any of the other instrument circuitry. The cooler outgas heater and TCE may not be proportionally controlled.

5.11.2. Temperature Measurements Requirements

Stable high resolution sensors shall be used to measure all critical temperatures for which a high resolution readout is required. Sensors shall be accurate to better than 0.1^{o}C. They shall be stable to better 0.2^{o}C over the anticipated life of the system including storage time. The readout circuitry shall be built to achieve temperature measurement accuracies of 0.05^{o}C or better over the range of 0^o to 60^{o}C for filter wheel housing and internal warm target.

5.12. CONNECTOR REQUIREMENTS

5.12.1. Test Points

A separate test connector (female) shall be provided to permit selected signals within the HIRS/3/4 to be monitored while the unit is under test on the bench or on the spacecraft for determining rapid fault isolation to the replacement assembly. The separate test connector shall include input and internal bus monitoring points. Test points shall be internally buffered if subsystem performance would be affected when monitoring. Short circuit protection of test points shall be provided. The HIRS/3/4 shall operate within specification while a test point is shorted. Test connectors shall be stowed and no connections made to them during acceptance testing and calibration.

5.12.2. HIRS/3/4 Spacecraft Interface Connectors

The contractor shall provide separate connectors for the following inputs and outputs:

1. One connector for power and grounds from the spacecraft.

2. One connector for all TIP signals, A_1, C_1, D_1 output, major frame sync pulse, calibration pulse and the 1 Hz clock.

3. A separate connector for the 1.248 MHz clock.

4. A separate connector for commands.

5. A separate connector for the Digital B outputs to TIP.

6. A Separate connector for the analog signals to TIP.

5.12.3. Connector Mechanical Requirements

The shells of all external connectors shall be made from nonmagnetic material and shall have electrically conductive finish. Cadmium plating shall not be used. Connector contacts shall be gold plated. Silver plating shall not be used under the gold plating. Connectors shall be keyed, have different numbers of contacts or be of different sex to prevent accidental mismating. On the chassis, male connectors shall be used for power and input signals, and female connectors shall be used for output signals. Ten percent of the total number of contacts on each connector shall be spares (not connected).

1. Connector Designations The connector designations shall be determined by the interface definition from the spacecraft contractor. The contractor may use his own designations until such information is provided.
2. Connector Marking Each connector shall be marked with the corresponding identification number and color shown on the electrical circuit diagrams. The marking shall be readily visible and shall contrast with the surface on which it is displayed.

5.12.3.1. Connector Savers

Connector savers shall be provided and installed on the instrument's flight connectors as soon as the instrument is assembled. The connector savers shall be used to reduce to a minimum the number of mate/demate cycles of the instrument flight connectors. Mates and demates on the flight connectors shall be limited to 30 mates and 30 demates each. Mate/demate logs shall be established and maintained for all flight instrument interface connectors. Connector savers shall be constructed using standard wire and flight quality connectors.

5.12.4. Spacecraft Cabling Interface Requirements

Table 6 lists detailed information on all connectors interfacing with the spacecraft. The information includes pin assignment, connector type, and signal specification on each pin. The location of the interface connectors shall be in the direction of the +Z axis, i.e., opposite to the facing direction of the cooler.

5.13. MAGNETIC (NOT USED)

5.13.1. Instrument Generated Magnetic Fields (NOT USED)

5.13.2. Instrument Magnetic Susceptibility (NOT USED)

5.13.3. Magnetic Compensation (NOT USED)

5.13.4. Instrument Degaussing (NOT USED)

5.13.5. Magnetic Field Environment (NOT USED)

Table 6

Interface Connectors

HIRS/3/4 Interface Connector Types and Pin Assignments

Connector No.	Function	Style	Type
J1	Clock	9 Pin Male	GSFC 311P405-1P-C-12
J2	Power	25 Pin Male	GSFC 311P405-3P-C-12
J3	Command	37 Pin Male	GSFC 311P405-4P-C-12
J4	Analog TLM	37 Pin Female	GSFC 311P405-4S-C-12
J5	Digital TLM	25 Pin Female	GSFC 311P405-3S-C-12
J6	Data	15 Pin Male	GSFC 311P405-2P-C-12
J7	Test	50 Pin Female	GSFC 311P405-5S-C-12
J8	Heater	9 Pin Female	GSFC 311P405-1S-C-12
J9	Cooler Test	15 Pin Female	GSFC 311P405-2S-C-12

Connector Type 9 Pin Male GSFC 311P405-1P-C-12

J1 Clock Connector

Pin No.	Function
1	1.248 MHz Clock High
2	1.248 MHz Clock Low
3	1.248 MHz Clock Shield
4	Clock Shield (Connected to J1, Pin 3)
5	Chassis Ground (Internal)
6	Spare
7	Spare
8	Spare
9	Signal Ground

Table 6 (continued)

Interface Connectors

Connector Type - 25 Pin Male GSFC 311P405-3P-C-12

J2 Power Connector

Pin No.	Function
1	+28 Vdc Reg. Bus (Electronics)
2	+28 Vdc Reg. Bus (Electronics)
3	+28 Vdc Pulse Bus (Scan)
4	+28 Vdc Pulse Bus (Scan)
5	+28 Vdc Pulse Bus (Filter)
6	+28 Vdc Pulse Bus (Filter)
7	+28 Vdc Reg. Bus (TLM)
8	+28 Vdc Reg. Bus (Commands)
9	Spare
10	Spare
11	+10 Vdc Bus (Interface Power)
12	Spare
13	Chassis Ground
14	+28 Vdc Reg. Bus Rtn (Electronics)
15	+28 Vdc Reg. Bus Rtn (Electronics)
16	+28 Vdc Pulse Bus Rtn (Scan)
17	+28 Vdc Pulse Bus Rtn (Scan)
18	+28 Vdc Pulse Bus Rtn (Filter)
19	+28 Vdc Pulse Bus Rtn (Filter)
20	+28 Vdc Reg. Bus Rtn (TLM)
21	+28 Vdc Reg. Bus Rtn (Commands)
22	Spare

Table 6 (continued)(Mod 120)

Interface Connectors

Connector Type - 25 Pin Male GSFC 311P405-3P-C-12

J2 Power Connector (continued)

Pin No.	
23	Spare
24	+10 Vdc Bus Rtn (Interface Power)
25	Signal Ground

Connector Type 37 Pin Male GSFC 311P405-4P-C-12

J 3 Command Connector

Pin No.	Function	Pin No.	Function
1	Inst. Pwr On	20	Cooler Heat On
2	Inst. Pwr Off	21	Cooler Heat Off
3	Electronics On	22	Patch Control On
4	Electronics Off	23	Patch Control Off
5	Scan Motor On	24	Space Position
6	Scan Motor Off	25	Nadir Position
7	Filter Motor On	26	Cooler Door Enable
8	Filter Motor Off	27	Cooler Door Disable
9	IWT Position	28	Calibration Enable
10	ICT Position	29	Calibration Disable
11	Filter Heat On	30	Cooler Door Deploy
12	Filter Heat Off	31	Filter Motor Power High
13	Position Disable	32	Filter Motor Power Normal
14	Spare	33	Spare
15	Spare	34	+10V I/F GND A HIR RTN / Spare

Table 6 (continued) (Mod 120)

Interface Connectors

Connector Type 37 Pin Male GSFC 311P405-4P-C-12

J 3 Command Connector (Continued)

Pin No.	Function	Pin No.	Function
16	Spare	35	+10V I/F GND B HIR RTN / Spare
17	Spare	36	Spare
18	Spare	37	Signal Ground
19	Chassis Ground		

Connector Type 37 Pin Female GSFC 311P405-4S-C-12

J 4 Analog Telemetry

Pin No.	Function	Pin No.	Function
1	Radiator Temp. TLM	20	Filter Motor Current TLM
2	Baseplate Temp. TLM	21	Scan Motor Current TLM
3	Electronics Temp. TLM	22	Patch Control Pwr. TLM
4	Patch Temp. TLM	23	Spare
5	Filter Hsg. Current TLM	24	Spare
6	Scan Motor Temp. TLM	25	Spare
7	Filter Motor Temp. TLM	26	Spare
8	Spare	27	Spare
9	+5 Vdc TLM	28	Spare
10	+10 Vdc TLM	29	Spare
11	+7.5 Vdc TLM	30	Spare
12	-7.5 Vdc TLM	31	Spare
13	+15 Vdc TLM	32	Spare
14	-15 Vdc TLM	33	Spare

Table 6 (continued)

Interface Connectors

Connector Type 37 Pin Female GSFC 311P405-4S-C-12

J4 Analog Telemetry (continued)

Pin No.	Function	Pin No.	Function
15	Spare	34	Spare
16	Spare	35	Spare
17	Spare	36	Spare
18	Spare	37	Signal Ground
19	Chassis Ground		

Connector Type 25 Pin Female GSFC 311P405-3S-C-12

J5 Digital Telemetry

Pin No.	Function
1	Instrument Power ON/OFF
2	Electronics Power ON/OFF
3	Filter Motor Power ON/OFF
4	Scan Motor Power ON/OFF
5	Cooler Heat ON/OFF
6	Filter Housing Heat ON/OFF
7	Cover Release Enable/Disable
8	Window Heater ON/OFF
9	Go to Nadir Position ON/OFF
10	Calibration Sequence Enable/Disable
11	Cover Closed YES/NO
12	Cover Open YES/NO
13	Chassis Ground

Table 6 (continued)

Interface Connectors

Connector Type 25 Pin Female GSFC 311P405-3S-C-12

J5 Digital Telemetry (continued)

Pin No.	Function
14	Filter Motor Power Mode NORMAL/HIGH
15	Patch Temp. Control ON/OFF
16	Spare
17	Spare
18	Spare
19	Spare
20	Spare
21	Spare
22	Spare
23	Spare
24	Spare
25	Signal Ground

Connector Type 15 Pin Male GSFC 311P405-2P-C-12

J6 Data Connector

Pin No.	Function
1	Major Frame Sync Pulse (32 sec)
2	Calibration Pulse (256 sec)
3	TIP Data Enable Signal (Digital "A" Select)
4	TIP 8320 Hz Clock
5	Digital "A" Data
6	1 Hz Clock

Table 6 (continued)

Interface Connectors

Connector Type 15 Pin Male GSFC 311P405-2P-C-12

J6 Data Connector (continued)

Pin No.	Function
7	Spare
8	Chassis Ground
9	Spare
10	Spare
11	Spare
12	Spare
13	Spare
14	Spare
15	Signal Ground

Connector Type 9 Pin Female GSFC 311P405-1S-C-12

J8 Pulse Load HTR Connector

Pin No.	Function
1	Heater #1
2	Heater #2
3	Sensor #1
4	Sensor #2
5	Chassis Ground
6	Spare
7	Spare
8	Spare
9	Signal Ground

Table 6 (continued)

Interface Connectors

Connector Type 15 Pin Female GSFC 311P405-2S-C-12

J9 Cooler Test Connector

Pin No.	Function
1	Spare
2	Spare
3	+28 Vdc Cooler Heater PWR
4	Spare
5	Patch Outgas Heater (Fused through connector mate to pin 3 for flight)
6	Spare
7	Spare
8	Chassis GND
9	Spare
10	Spare
11	+28 Vdc Cooler Heater PWR
12	Spare
13	Radiator Outgas Heater (Fused through connector mate to pin 11 for flight)
14	Spare
15	Spare

Table 6 (continued)
Interface Connectors

Connector Type 50 Pin Female GSFC 311P405-5S-C-12

J7 Test Connector

Pin No.	Function	Pin No.	Function
1	A0 Test Point (TP)	27	Scan Motor Temp. TP
2	B0 T	28	IWT #1 T TP
3	FW0A TP	29	IWT #2 T TP
4	FW0B TP	30	IWT #3 T TP
5	FW Sync TP	31	IWT #4 T TP
6	LW CTL2 TP	32	-10 V Ref. TP
7	SW CTL2 TP	33	Radiator Temp. TP
8	LW CH CLMP TP	34	ICT #1 T TP
9	LW INT TP	35	Baseline Clamp Timing
10	SW CH. CLMP TP	36	10 PPS
11	SW INT TP	37	Channel Clock
12	LW COMP Video TP	38	Patch T Full Range TP
13	SW COMP Video TP	39	Patch T Expanded TP
14	LW Clamped Video TP	40	Patch Cont. HTR Voltage TP
15	LW INT OUT TP	41	-2.5 V Ref. TP
16	LW OS Video TP	42	FW Hsg. #1 T TP
17	SW Clamped Video TP	43	FW Output Voltage
18	SW INT OUT TP	44	Scan Reg Output Voltage
19	SW OS Video TP	45	Scan Position LSB
20	E. CAL. SIG. TP	46	Tach Out Lo TP
21	Step O TP	47	Tach Out Hi TP
22	Primary Telescope Temp. TP	48	CLR Hsg. Sensor #1(H301-H303)
23	Scan Mirror Temp. TP	48	SEO(H304-H307)
24	Secondary Telescope Temp. TP	49	CLR Hsg. Sensor #2(H301-H303)
25	Chassis Ground	49	Bias Off Control (H304-H307)
26	Baseplate Temp. TP	50	Signal Ground

5.14. CONDUCTED SUSCEPTIBILITY

The radiometer shall perform within specifications in the presence of sinusoidal noise coupled into the power lines between the frequency range of 30 Hz to 150 kHz. See TIROS-N GIIS, Section 3.6.1.2 for additional information.

The method specified in MIL-STD-462 CS01 shall be used to inject noise between 30 Hz and 50 kHz; CS02 shall be used to inject noise between 50 kHz and 150 kHz.

Bus	Injected Voltage
+28 v Bus/TCE Bus	300 mv p-p
+28 v Pulse Load Bus	400 mv p-p
+10 v Interface Bus	100 mv p-p

The instrument shall operate without degraded performance when subjected to a series of transient pulses, 10 microseconds in width and repetition rate of 10 Hz applied to the power lines for ten minutes duration. Test method CS06 as described in MIL-STD-462 is applicable.

Bus	Spike Level
+28 v Main Bus	+ 10 v and - 12 v
+28 v TCE Bus	+ 8 v and - 13 v
+10 v Interface Bus	+ 1 v and - 1 v

5.15. RADIATED SUSCEPTIBILITY

The instrument shall operate within specification while subjected to a radiated electric field of one volt per meter for frequencies between 150 kHz and 500 MHZ except that in the band of 136 MHZ to 139 MHZ and 1605 MHZ to 1710 MHZ the field strength shall be 10 volts/meter. The radiated carrier in the band between 136 and 139 MHZ shall be 50% amplitude modulated at a frequency of 8.32 kHz. Modulation at S-band is not required. Testing shall be conducted in accordance with MIL-STD-462, RS03.

5.16. RADIATED ELECTROMAGNETIC INTERFERENCE (EMI)

5.16.1. EMI Construction Techniques (NOT USED)

5.16.2. Radiated EMI

The HIRS/3/4 instruments shall meet the radiated EMI requirements listed in Table 7. as a goal. The first flight unit instrument shall be tested for radiated EMI for information only and the results documented in the A&E Handbook. See paragraph 3.6.1.4 Radiated Emissions of the (GIIS),for additional information.

Table 7

Maximum Radiated EMI Requirements

For the discrete DCS and SARP EMI sensitive bands listed below, broad band noise and discrete signals shall not exceed -60 dbm.

59.458 MHZ ∀ 0.5 kHz	60.10 MHZ ∀ 0.5 kHz
141.360 MHZ ∀ 0.5 kHz	142.9 MHZ ∀ 0.5 kHz
282.733 MHZ ∀ 0.5 kHz	285.813 MHZ ∀ 0.5 kHz
371.921 MHZ ∀ 0.5 kHz	375.972 MHZ ∀ 0.5 kHz
624.925 MHZ ∀ 0.5 kHz	631.730 MHZ ∀ 0.5 kHz
743.841 MHZ ∀ 0.5 kHz	751.944 MHZ ∀ 0.5 kHz

Max. Level (dbm)	121.5 MHZ Band	243 MHZ Band	406.05 MHZ Band	401.650 MHZ Band
-100	118.500-120.000	237.000-240.000	396.100-401.000	
-125	120.000-121.450	240.000-242.925	401.000-405.900	396.100-401.500
-145	121.450-121.485	242.925-242.975	405.900-406.000	401.500-401.600
-150	121.485-121.515	242.975-243.025	406.000-406.100	401.600-401.700
-145	121.515-121.550	243.025-243.075	406.100-406.200	401.700-401.800
-125	121.550-123.000	243.075-246.000	406.200-411.000	401.800-406.000
-100	123.000-124.500	246.000-249.000	411.000-416.000	

Resolution Bandwidth: 100 Hz for -150 dbm and -145 dbm
1000 Hz for -125 dbm
3000 Hz for -100 dbm

Command Receiver Band

Band (MHZ)	2 kHz Bandwidth Max. Sign. Level (dbm)
2000-2040	-120

5.17. CONDUCTED EMISSION

The requirements of this section shall be implemented only if configuration changes warrant it.

An oscilloscope with a current probe, DC to 30 MHZ minimum bandwidth, may be used in lieu of an EMI meter as specified in MIL-STD-462 to determine if the allowable limits are exceeded. Photographs of traces shall have sufficient resolution to clearly indicate ripple magnitude, frequency and risetime to demonstrate compliance with this specification.

The measurements shall be performed on all power lines and returns interfacing with the spacecraft.

Test Method MIL-STD-462	Frequency Ranges
CE01	20 Hz - 20 kHz
CE02	20 kHz - 150 kHz

See TIROS-N GIIS for more information.

5.18. GROUNDING AND SHIELDING

The following paragraphs define the grounding and shielding requirements for the HIRS/3/4 circuits and the electrical interface between the HIRS/3/4 and the Tiros-N spacecraft.

5.18.1. Case Ground

The case ground is any chassis and/or box which houses electronic circuits in the HIRS/3/4.

1. The mounting surfaces of the case shall be finished with an electrically conductive finish. All case junctions shall be electrically conductive to optimize shielding.

2. The case shall be grounded to the spacecraft structure directly or via a ground bonding strap.

3. The case ground shall be DC isolated from all input and output circuitry by at least 10 megohms.

4. The case ground shall be connected within the instrument via the shortest possible connecting lead to at least two contacts on each connector interfacing with the spacecraft.

5.18.2. Power Ground

1. The HIRS/3/4 shall have six separate power grounds:

   a. The +28 volt DC power return.

   b. The +28 volt motor power return.

   c. The +28 volt regulated telemetry power return.

   d. The +28 volt regulated command power return.

   e. The interface power ground return for the +10 volt power.

   f. The TCE heater power return.

2. Each power ground shall be DC isolated from all other grounds within the HIRS/3/4 by at least 100k ohms prior to external connection.

3. Each power ground shall be connected by a separate wire in the spacecraft harness to the spacecraft central ground point.

5.18.3. Signal Ground

1. Signal ground shall be DC isolated from the 28 volt power input circuit by means of a DC to DC converter.

2. DC isolation between signal ground and the 28 volt power ground shall be at least 10 megohms when the single point ground inside the instrument is lifted.

3. The signal ground shall not be connected to chassis ground within the instrument.

4. All single-ended input and output signal returns shall be connected to signal ground.

5.18.4. AC Power Grounds

AC power circuits, if used, shall be grounded as follows:

1. AC power ground shall be DC isolated from all other grounds (power, case, signal) by at least 10 megohms.

2. The AC ground shall be connected to the spacecraft central ground point by a separate wire in the spacecraft.

5.18.5. Shielding

1. The shield on any wire within the HIRS/3/4 may be connected to signal ground or case ground but not both. The ground connection shall be made at one end of the wire only unless EMI reduction requires otherwise.

2. Shields on spacecraft harness wires interfacing with the HIRS/3/4 which carry unbalanced outputs from the instrument shall be connected to the case ground contact in the mating connector at the instrument.

3. Shields on spacecraft harness wires interfacing with the HIRS/3/4 which carry unbalanced inputs to the instrument shall be connected to a pin in the mating connector at the HIRS/3/4. This pin is not connected to anything within the instrument.

4. Double-shielded spacecraft harness wires interfacing with the HIRS/3/4 which carry balanced signals shall have the outer shield connected to case ground through a pin in the mating connector at the instrument. The inner shield shall be connected to a pin in the mating connector at the instrument which is returned to signal ground.

6. MECHANICAL REQUIREMENTS

6.1. GENERAL MECHANICAL DESIGN REQUIREMENTS

6.1.1. Mechanical Outline and Weight Limits

The instrument envelope (including insulation and sun shield) shall not exceed dimensions as shown in the ITT outline drawing 8129882. The dimensions and weight of the HIRS/3/4 shall not exceed the following:

HIRS/3/4 Overall Dimensions: 26.65" x 17.95" x 16.0"
(0.677m x 0.456m x 0.407m)

HIRS/3/4 Total Weight: 74 pounds

6.1.2. Mechanical Safety Factors

The load bearing mechanical components of the instrument shall be designed for strength safety factor of 1.4 on ultimate considering the applicable qualification test requirements of this specification. All Flight hardware must be exposed to a sine burst and random test. CCR1618A MOD 177

6.1.3. Angular Momentum

The total uncompensated angular momentum vector of the filter wheel shall lie along the spacecraft -Z axis and shall not exceed 2 in.-lb-sec. The total uncompensated angular momentum component along each of the spacecraft roll and yaw axes shall not exceed 1 in.-oz-sec., and the total angular momentum component along each spacecraft axis shall be determined to 0.1 in.-oz-sec.

6.1.4. Natural Resonances

The minimum natural frequency of all components or combinations of components shall be greater than 100 Hz to avoid coupling with the spacecraft structure resonance.

6.1.5. Lubrication

The lubricant used for bearings, gears, and other mechanical drives must be consistent with the required life of the instrument in orbit. Oil and grease quantities added to bearings shall be determined by weight to the nearest 0.1 mg. The lubricant used shall be proposed by the Contractor and approved by the GSFC Technical Officer.

6.1.6. Screw Fastening

Approved adhesives shall be used to prevent loosening of screws during environmental testing and launch.

6.1.7. Cements and Epoxies

The use of cements and epoxies should be minimized. Only cement and epoxies on the approved materials list may be employed. Mechanical backup shall be provided where cement or epoxies are used for the fastening of optical or mechanical components.

6.1.8. Identification Name Plate and Marking

All HIRS/3/4 hardware shall be marked with the name of the unit, part number, serial number, and connector designations per MIL-STD-130D.

1. Name Plates All deliverable end items shall be permanently marked with a label of the following form:

Instrument: HIRS/3
Contractor: ITT
S/N: (H301, H302, H303 as appropriate)
Instrument: HIRS/4
Contractor: ITT
S/N: (H304, H305, H306, and H307 as appropriate)

2. Marking of Support Hardware, Cables, and Shipping Containers All support hardware must be marked or tagged to insure against loss and to facilitate its usage. Test cables should be tagged, numbered, and identified with the instrument hardware. The same applies to test equipment, and miscellaneous test, and support equipment.

6.1.9. Instrument Shipping Containers

The shipping containers will be Government-furnished. They are designed to protect the instruments and are suitable storage containers and carrying cases for the instruments. The containers are capable of being pressurized with dry nitrogen and include shock protection and shock and temperature recorders.

The contractor shall purge and pressurize the containers with dry nitrogen and service the recorders as required whenever an instrument is placed in a container.

The Contractor shall provide one shipping container to be used for shipping the HIRS to its European MetOp destination. The container shall be capable of being pressurized with dry nitrogen and shall have a shock and temperature recorder. The container shall be able to withstand air transportation and have a shock mount that will limit the load on the HIRS instrument to less than 20 g’s when subjected to an 8” drop above a concrete floor. CCR 1821 MOD 205

6.1.9.1. Marking Shipping Container

Each shipping container shall be externally marked with the following information:

1. Manufacturer's part number.
2. Flight unit's model and serial number.
3. Purchase order number.

In addition, any special handling or unpacking directions which are required shall be prominently displayed on the outside of the shipping container.

6.1.10. Handling Fixture

One fixture is to be provided for the METOP.

6.1.11. Bearings

Bearing enclosures and output shafts shall be provided with labyrinth seals.

6.1.12. Center of Gravity

The center of gravity shall be measured on each instrument to within 0.2 in. as part of the qualification and acceptance testing.

6.1.13. Materials

Nonmagnetic materials shall be used whenever possible. Cadmium and zinc metal shall not be used in the construction of the radiometer.

1. Moisture and Fungus Resistance Materials that are not nutrient for fungi shall be used whenever possible. The use of materials that are nutrient to fungi is not prohibited in hermetically sealed assemblies. If

it is necessary to use nutrient materials in other than the above qualified applications, these nutrient materials shall be treated by a method that renders the resulting exposed surface fungus resistant.

2. Corrosion of Metal Parts   Metal parts shall be made from materials inherently corrosion resistant or shall be processed to resist corrosion. Bare aluminum shall be used only where infrared properties permit no substitute.

3. Outgassing of Material   Materials shall not outgas, vaporize, or otherwise degenerate in a space environment in a manner and to a degree as to interfere with the operation of the instruments. Each component shall be free from residual contaminants such as corrosion, inhibiting oils, greases, dyes, shim stock and similar debris.

4. Materials Selection   Selection criteria for outgassing shall be based on Goddard Report, "A Compilation of Low Outgassing Polymeric Materials Normally Recommended for GSFC Cognizant Spacecraft," X-764-71-314. The maximum weight loss shall be 1.0 percent or less and the maximum volatile condensable materials shall be 0.1 percent or less.

5. Materials and Process Listing   The contractor shall prepare and furnish a materials and process list for the materials used in the HIRS/3/4 prior to the preliminary design review meeting. It will categorize all materials listed as metals, plastics, coatings, miscellaneous, etc., and adequately identify the items by government specification, process, cure cycle type, chemical composition and/or manufacturer. The listing will also specify the application(s) of each material in the subsystem.

The volume and surface area of each material will be indicated using the code outlined below:

Volume		Surface Area	
Code	cc	Code	cc
A	0 to 1	1	0 to 1
B	1 to 50	2	1 to 100
C	50 to 100	3	100 plus
D	100 plus		

6.1.14. Finish

The external finishes applied to the scanner unit shall satisfy the optical and thermal requirements of the spacecraft and the HIRS/3/4.

6.1.15. Maintainability

Maintainability factors to be considered shall include:

Use of standard parts, tools and test equipment; interchange ability, including replacement of printed circuit boards; minimum need for adjustments, alignments, and calibrations; easy identification of fault detection and isolation techniques, and fail safe design features.

6.1.16. Protective Covers

Protective covers shall be provided to cover the scan mirror optical port and cooler radiator area. These covers shall provide protection while in the shipping container and during the time the instrument is mounted on the spacecraft and shall minimize dust or other contaminants from entering these areas. The optical port cover shall not prevent the operation of the scan system. They shall be RF transparent. Design of the protective covers for the scan mirror optical port and the cooler radiator covers shall incorporate the following criteria:

- Captive hardware shall be utilized for mounting the covers to the instrument.
- Protective covers may be specific to each instrument.
- Slotted holes shall be eliminated as required to prevent interference between the dust cover and the instrument.
- Blankets shall be provided to aid in light blocking during specific instrument tests. Blankets shall incorporate a removable blanket panel on the Nadir side. Protective covers shall include Velcro for blanket attachment.
- The protective covers shall be designed for use with and without all blankets.
- The covers shall not have excessive movement.
- Hardware locations shall be designed so that installation does not require positioning adjustments.
- Contact gaskets or Kapton tape shall be installed on the protective covers so that marring of the painted surfaces will be minimized.
- The design shall provide adequate clearance at the location of the latch.

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Covers for all electrical connectors shall also be provided. Flyable covers shall be provided for the test connectors. The cover for the cooler test connectors shall serve as a fused shorting plug and must be in place for flight.

6.1.17. Scanner Alignment

A method shall be provided for measurement of the alignment of the HIRS/3/4 optical axis with respect to three external reference surfaces on the instrument frame. Provision shall be made to permanently attach up to three alignment mirrors at TBD locations on each instrument. See GSFC document, Alignment Mirror Adhesive Evaluation, X-722-77-14, dated January, 1977 for more information. These mirrors, in turn, may be used to boresight the HIRS/3/4 to the spacecraft and must be located in a convenient position for this purpose. The measurement of the optical axis alignment with the mirrors shall have an accuracy of $\pm$0.01 degree.

6.1.18. Decomposition Products

Design provisions shall be made to avoid any adverse effects from orbit and attitude adjust subsystem combustion products: H_2, N_2, NH_3, H_2O.

6.1.19. Venting

Venting shall be sufficient to allow the instrument to withstand the launch pressure profile, which for a TITAN II, will be approximately twice as fast as for the ATLAS-E.

6.2. INSTRUMENT MECHANICAL REQUIREMENTS

6.2.1. General

The HIRS/3/4 shall consist of a main frame (or base), a scan assembly, a filter/chopper assembly, an optical assembly, an electronics assembly, a target assembly and a cooler. See Figure 3. HIRS/3/4 Major Components.

6.2.2. Main Frame

The main frame is the principal structure of the instrument to which all other components are mounted.

6.2.2.1. Alignment The main frame shall maintain the relative alignment of the assemblies mounted thereon, to the accuracy specified in paragraph 6.2.4 and 7.4., as well as the alignment of the HIRS/3/4 optical references on the spacecraft. The reference axes are defined as follows: The X, Y, and Z instrument reference axes shall correspond to the spacecraft X, Y, and Z axes. Therefore, the instrument mounting plane is the Y-Z plane, the scan plane is the X-Z plane, and the +X axis is nadir. The instrument mounting feet shall have a coplanarity of 0.001 in., and the mounting hole pattern shall be aligned to within 0.1 degrees of the instrument Y and Z axes.

6.2.2.2. Spacecraft Interface Requirements The mounting face of the HIRS/3/4 shall be considered part of the main frame and as such shall include the mounting feet, thermal insulation, and any other interface connected subassemblies.

6.2.2.3. Mounting Hole Pattern The mounting hole pattern shall be identical to the HIRS/3/4 instruments delivered under contract NAS5-30384 and identical to the pattern in the drill jigs delivered under that contract for the instruments.

6.2.3. Drill Jigs

The contractor shall use, maintain and replace if necessary the two HIRS/3/4 drill jigs. One shall be a master to be used in drilling the mounting holes in the HIRS/3/4. The second shall be a matching master used in drilling the mounting holes in the spacecraft. A drawing of the fixture shall be submitted to the Technical Officer prior to fabrication of any new drill jigs. The fixtures and their associated information include:

1. Permanent drill bushing with slip bushing insets, sized to accommodate mounting bolts.
2. Orientation marks or optical devices to allow positioning of the fixture to the desired alignment accuracy.
3. Marking to indicate which surface of the fixture contacts the spacecraft.
4. Mounting hole locations and tolerances.
5. Outline of drill fixtures.
6. Outline of HIRS/3/4 package.
7. Orientation of fixture with respect to spacecraft axes.
8. Size of mounting hardware.

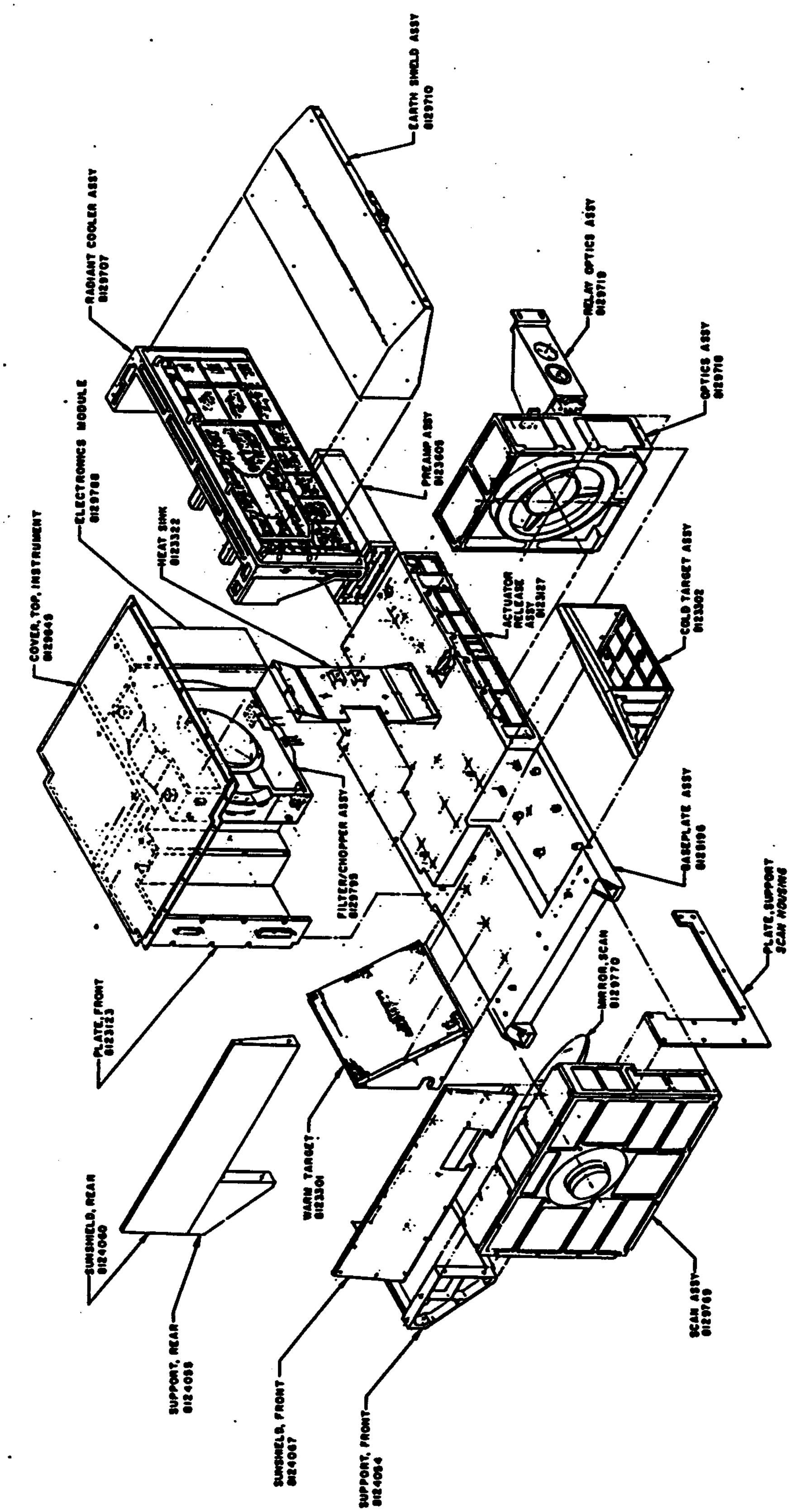

Figure 3. HIRS/3/4 Major Components

6.2.4. Scan Assembly

The scan assembly shall be built to meet the required performance and shall be designed to achieve a stepping accuracy of 1.8 $\pm 0.1^{o}$ per step and an accumulative cross scan accuracy of $\pm 0.2^{o}$ with respect to true position. The scan mirror shall be stepped and critically damped to within 0.1 degrees of nominal position within 35 ms (goal of 25 ms). The scan mirror surface coating shall be designed in such a way as to minimize its emissivity and instrument polarization. The scan assembly stepping angles shall be read out with an optical digital angle encoder having a resolution of 1.8 degrees and an alignment error no greater than ± 0.2 degrees.

6.2.5. Filter/Chopper Assembly

The filter/chopper assembly contains the filter wheel, chopper, filter/chopper motor and shroud.

6.2.5.1. Filter/ Chopper Motor

The motor shall have adequate torque to operate properly (within instrument timing and NEDN requirements) at the end of lifetime and over the instrument϶s temperature range. The system shall have a minimum demonstrated start of life torque of 1.0:1 with the motor commanded in either NORMAL POWER or HIGH POWER mode. Torque margin equals the ratio of available motion torque to bearing drag torque, minus one. The motor shall be operated during launch phase.

The motor stall torque shall have a minimum margin of 2 over the bearing break away torque with the motor commanded in NORMAL POWER or HIGH POWER mode.

6.2.5.1.1 Definitions

6.2.5.1.1.1 Bearing Drag Torque

Bearing Drag Torque is measured in the motor at the normal operating speed and ambient temperature (22^{o}C), with the windings disconnected from the circuit.

6.2.5.1.1.2. Phase Reference Pickup (PRP)

The PRP shall be built to permit sufficient mechanical adjustment of the PRP signal phase relative to the scene signal, and all components of the PRP subassembly shall be redundant.

6.2.6. Optical Assembly

The optical assembly shall consist of the telescope relay optics and detector subassembly.

6.2.7. Electronics Assembly

The electronics assembly shall contain all of the system electronics and shall be completely contained within the main instrument package. All electronics shall be built and constructed to provide electromagnetic shielding of all sensitive circuitry from the transient fields created by the dc/dc converters and stepper motor circuitry.

6.2.8. Internal Warm Target (IWT)

The warm target assembly shall consist of a honeycomb blackbody mounted to the main frame in a position to be viewed during instrument back scan. This target shall operate at baseplate temperature, approximately 288^{o}K. It is used along with space for in-orbit calibration. It shall be built to have as uniform a temperature as possible.

1. Target Configuration The configuration of the warm calibration target (approx. 288°K) shall be such as to achieve a spectral emittance of 0.99 or better in the spectral range of this instrument. The design of this target shall be such as to minimize its view of Earth.

2. Temperature Measurement The temperature of the calibration target shall be monitored by means of several resistance thermometers mounted on the back plate, each of which shall have a temperature resolution of 0.1°C with a goal of 0.05°C. The quantities, types and locations of the resistance thermometers shall be optimized for the best possible measurement of the target temperature.

6.2.9. Cooler Assembly

The radiative cooler shall consist of the housing, door, first stage and patch. It shall be built to operate under control at 100°K for H301 to H303 and 95°K for H304 to H307, with a demonstrated margin (H301 to H307) of 5.0°K or greater for an orbital condition where the baseplate is at +15°C and the solar angle may be any angle from 0° to +80°. The HIRS/3/4 radiative cooler shall not interfere with the operation of other instrument radiative coolers on the IMP.

6.2.9.1. Cooler Door Subassembly

The cooler door will be closed during the launch phase. Once the spacecraft reaches stable orbit, the cooler door will be commanded permanently open following completion of a 14 day cooler outgassing period.

6.2.9.2. Outgassing Heaters

The cooler shall be fitted with outgassing heaters to be capable of heating the patch to 300°K ±2° with the door closed.

6.3 METOP SPECIFIC REQUIREMENTS CCR 1618A MOD 177

6.3.1 Exceptions to METOP ICD

6.3.1.1 Random Vibration Environment

The qualification and acceptance levels for the random vibration environment shall be 3db below those in Table 4.1.2.4 of the METOP ICD, MO-IC-MMT-0001, June 11th, 1998, Rev. 0.

6.3.1.2 Instrument Shock Environment

The shock environment shall be as shown in Section 4.1.1.3 of the METOP ICD, MO-IC-MMT-HI-0001, June 11th, 1998, Rev. 0. However, this environment will be considered at the interface of the deployable, boom, antenna, etc. that causes the shock load, not at the instrument interface as is implied in the ICD.

6.3.1.3 Vibration Test: High Level Sine Sweep

The qualification levels for the METOP High Level Sine Sweep are as shown below.
6-20 Hz ±9.3 mm
20-60 Hz ±15 g
60-70 Hz ±6 g
70-100 Hz ±3.3 g
Sweep Rate 2 Oct/Min
These levels are to be met in all three axes. CCR1618A MOD 177
Acceptance levels are shown below.
6-20 Hz ±7.5mm
20-60 Hz ±12 g
60-70 Hz ±4.8 g
70-100 Hz ±3.3 g (TBC by ITT,METOP. This value will not be higher than 3.3 g).
Sweep Rate 4 Oct/Min

These levels are to be met in all three axes.

6.3.2 Factors of Safety

Stress analyses of the instrument shall show a positive margin of safety using a factor of safety on ultimate of 2.0 on qualification levels. Hardware qualified in this manner shall be tested to acceptance levels.

6.3.3 Instrument Testing

If qualified by test, the instrument shall be qualification tested for all environments.

7. OPTICAL REQUIREMENTS

7.1. GENERAL

The HIRS/3/4 optics shall consist of a scan mirror, telescope, spectral bandpass filters, a beam chopper, relay optics and detectors.

7.2. SPECTRAL REQUIREMENTS

The spectral bandpass requirements are listed in Table 1 (Page 25).

7.2.1. Out of Band Response

The out of band transmission characteristics of the filters shall be designed to provide a calculated, total instrument integrated out of band response less than 0.1% of the total integrated response, where "out of band" is defined as beyond the 0.05% absolute response points.

7.3. FIELD OF VIEW (FOV) REQUIREMENTS

7.3.1. FOV Width

The HIRS/3 Field of View shall be circular and shall have a nominal half-power full width for all channels of 1.4^o, a minimum of 1.3^o (1.28^o for Channel 1) in the long wave and 1.39^o in the short wave and a maximum of 1.5^o. The instrument design shall be such that for a uniform target at least 98% of the energy reaching the detector shall be contained within a circular FOV having a width of 31 mrad (1.8^o).

The HIRS/4 Field of View shall be circular with a nominal half-power full width of $0.69^o \pm 0.04^o$. The instrument design shall be such that for a uniform target at least 98% of the energy reaching the detector shall be contained within a circular FOV having a width of 31 mrad (1.8^o).

7.3.2. Image Motion Error

The image motion error (smear) during any one sampling interval of a channel shall be less than 0.015 degrees HIRS/3/4.

7.3.3. Baffling

The telescope shall contain sufficient optical baffling to prevent scene radiation reaching the detectors from outside a circular FOV having a width of 34 mrad (2^o).

7.4. OPTICAL ALIGNMENT

7.4.1. Precision

The alignment of the instrument optical axis to the instrument references shall be measured with an accuracy of 0.01 degrees or better.

7.4.2. Alignment Requirements

In any scan step, the optical axis shall be aligned to the scan plane, as defined by the instrument X and Z reference axes, to 0.1 degrees or better, and in scan step 27 the angle between the projection of the optical axis on the scan plane and nadir shall be $0.9^o \pm 0.1^o$.

7.4.3. Alignment Changes

The alignment of the instrument optical axis with respect to the instrument references and to the instrument mounting surface shall not be changed by more than ±0.05^{o} as a result of any qualification level testing.

7.4.4. Alignment Mirrors

Up to three small alignment mirrors shall be supplied, where two will be permanently attached at the scanner housing and the "+y" surface on each flight instrument. See GSFC document Alignment Mirror Adhesive Evaluation, X-722-77-14, dated January, 1977 for more information on adhesives for these mirrors. These mirrors will be used to boresight the HIRS/3/4 to the spacecraft and must be located in a convenient position for this purpose. The measurement of the optical axis alignment with the mirrors shall have an accuracy of ±0.17 milliradians.

7.5. CHANNEL REGISTRATION ERROR

7.5.1. Definition of Registration Error

Registration error between two sounding channels is defined as half the integral of the modulus of the difference between the normalized field-of-view response functions for the two channels, the integral being with reference to solid angle and extending over the solid angle range for which one or both of the response functions are non-zero.

The term "normalized field-of-view response function" describes the response of the radiometer to a uniform intensity collimated beam of light filling the entrance aperture from a defined direction in three dimensional space, the normalization being such that the integral of the function over the solid angle is unity.

7.5.2. Registration Requirements

The channel-to-channel registration among the LW channels for a single scan step shall be such that the FOV radiometric response centroids shall be superimposed on the 900cm^{-1} channel to within ±1.5% of the total FOV width (1.8^{o}). The half-power FOV of each channel shall match the half-power FOV of the LW channel to within 90%, except for channel 1. As a goal the common area overlap of any pair of FOVs shall be no less than 95% of the average area of these same two FOVs.

The channel-to-channel registration among the SW channels, including the visible channel, for a single scan step shall be such that the FOV radiometric response centroids shall be superimposed on the 2660cm^{-1} channel to within:

HIRS/3 ∀1% and
HIRS/4 ±2%

of the half-power FOV width. The half-power FOV of each channel shall match the half-power FOV of the 2660cm^{-1} channel to within:

HIRS/3 ∀1% and
HIRS/4 2%.

7.5.3. Registration Goals

The channel-to-channel registration among all the channels for a single scan step shall be such that the FOV radiometric response centroids shall be superimposed on the 900 cm^{-1} channel to within ±1.0% of the half-power FOV width. The channel half-power FOV shall match the half-power FOV of the 900cm^{-1} channel to within ±1.0%.

8. THERMAL REQUIREMENTS

8.1. GENERAL

This section outlines the thermal design approach and interface requirements necessary to achieve proper thermal control of the instrument. More detailed information is contained in the TIROS-N HIRS/3/4 UIIS.

8.2. SPACECRAFT THERMAL INTERFACE

The HIRS/3/4 will be mounted on the spacecraft Instrument Mounting Platform (IMP), but shall be independent of the spacecraft interface to the fullest extent possible. The HIRS/3/4 shall be in thermal contact with the IMP through the mounting feet only, and the design shall be such that under operation in the mission mode there will be no net heat flow between the IMP and the HIRS/3/4.

8.2.1. Active Thermal Control

The thermal design of the instrument shall utilize to the fullest extent heat transfer through the louver to space for thermal control. A louver assembly mounted on the spacecraft -X side of the IMP will be used for temperature control. The louver control sensor will be mounted on the HIRS/3/4 baseplate. Heater power may be required for operation in the mission mode, (but, in that eventuality, it must be counted as part of the HIRS/3/4 power budget) and is also available for louver failure (open), and instrument operation in the standby mode or launch mode. The total heater power available in any operating mode shall not exceed the total average power budget less the power dissipation in that mode. A louver surface area of 127 sq in. is available for the HIRS/3/4.

A dual Temperature Control Electronics (TCE) unit will be used to control heater and louvers. Additional radiator areas on other surfaces of the instrument may be used if necessary.

The IMP will be temperature controlled to 15°C ±1.5°C at the TCE sensor location. The HIRS/3/4 temperature set point Ts shall be 15±1°C. The ±1°C uncertainty is the allowable tolerance on the TCE sensor but the actual value will remain unknown until test. However, once established, Ts will not change.

8.2.2. Passive Thermal Control

The conductive heat transfer through the instrument mounting flanges shall not be used as the primary heat flow path. However, in the event of TCE failure, heat from the HIRS/3/4 will be conducted through the HIRS/3/4 mounting feet, through the IMP to the louver bimetallic springs. Under these conditions, T between louvers fully open and louvers fully closed will be approximately 10°C. In the failure mode the louvers will start to open when the TCE sensor on the instrument baseplate is approximately 2°C above its normal opening point. The geometry of the instrument mounting feet shall be configured to provide minimum contact area of 1.0 sq in. (6.45 cm^2) per foot. For instrument thermal analysis the following joint conductance values should be used: Bare metal joints 0.078 W/°C/cm^2, and RTV Filler 0.31 W/°C/cm^2.

8.2.3. Environmental Fluxes

8.2.3.1. Orbital Phase (NOT USED)

8.2.3.2. Launch and Orbital Acquisition Phase During the launch and orbital acquisition phases, the instrument will be exposed to launch vehicle shroud heating, aerodynamic heating, and Sun angles different from those expected during the orbital phase. In addition, there may be a period of time before turn-on when the instrument is fully eclipsed.

8.3. DESIGN REQUIREMENTS

8.3.1. Nominal Operating Temperature and Relative Humidity Range

The HIRS/3/4 shall meet all performance requirements of this specification in the nominal temperature range of +10^{o}C to +20^{o}C as measured at the baseplate. This temperature range is derived from the operating temperature of the IMP. The thermal design shall be adequate to maintain the HIRS/3/4 within these temperature limits when operating in the mission mode. However, these numbers are not rigid. The contractor can open his nominal temperature operating range if thermal design considerations require it. But the unit must be calibrated and operate within specification over the entire range.

The radiometer optical coatings shall be designed to withstand exposure to a relative humidity of 95 percent at +30 degrees C for 24 hours. The instrument shall also be designed to withstand operation in an environment whose relative humidity may vary from 25 to 60 percent.

8.3.2. Survivable Temperature Range

The HIRS/3/4 shall be built to survive periods in orbit during which the instrument will be in the standby mode, i.e., OFF. It must survive temperature extremes of -10^{o}C and +30^{o}C without degradation or failure. However, at these extreme temperatures, the instrument need not perform within specification.

8.3.3. Standby and Launch Phase Mode Heating

The contractor shall provide a heater, attached to the instrument baseplate, which will operate from the spacecraft main power bus. This heater is required to keep the instrument temperature as close to the nominal operating temperature as possible and can be used in all operating modes as required, provided its power dissipation is included in the instrument's total power budget.

8.3.4. Thermal Analysis

The contractor shall be responsible for the thermal design of the instrument for all phases of flight. The contractor shall provide a thermal Interface Control Drawing and a reduced thermal model for the METOP spacecraft contractor. If instrument improvements warrant, an update version will be made available to both spacecraft contractors via the Technical Officer. The requirements for the reduced thermal model are:

1. The model shall be less than 20 nodes.

2. The mounting feet and mounting surface adjacent to the spacecraft shall be included as nodes.

3. The reduced nodes shall be in tabulated form with the following minimum data for each node:

   a. Conductive and radiative couplings.

   b. Power dissipations, a power profile shall be included that contains maximum and minimum powers under all modes of operation.

   c. Thermal capacity.

   d. Heat absorbed by each external node (Sun, albedo, Earth IR) versus Sun angles and orbit times for at least the 0^o, 28^o, 68^o and 80^o Sun angle orbits.

   e. Surface areas, absorptances, emittances and external radiative couplings for all external nodes.

The instrument designer shall validate the reduced thermal model by making comparisons with his full-sized thermal model for at least 3 steady-state and 3 transient computer runs. The mean internal temperatures resulting from both models should agree within 3^oC. The heat transferred to or from the spacecraft should agree within approximately 2 W.

The worst case computer run shall be included in the thermal model data package.

8.3.5. Thermal Blankets

The contractor shall be responsible for the design of and shall supply any and all thermal blanketing which may be required including any additional blanketing to interface with the spacecraft blankets which may be required if the instrument extends beyond the spacecraft IMP.

9. PROGRAM SUPPORT REQUIREMENTS

9.1. PROGRAM REVIEWS

The contractor shall conduct the following reviews:

1. Critical Design Review - For new or modified elements of the program, this review shall occur after the design has been frozen but prior to the start of manufacture of flight components. It will emphasize implementations of design as well as test plans for flight systems including the results of engineering model testing.

2. Pre-environmental Review - This review shall occur prior to the start of environmental testing of the proto flight or flight system. The primary purpose of this review is to establish the readiness of the system for test and evaluate the environmental test plans.

3. Pre-shipment Review - This review shall take place prior to shipment of the flight instrument to GE/AE, and will concentrate on system performance during acceptance testing. The review shall cover all of the test data, the quality and reliability actions, the configuration management records and the malfunction report (MR) actions. All of the action items resulting from this review must be completed before the DD250 document is signed.

4. Quarterly Management Review - This review shall take place four times per year to formally present program status and progress to METSAT Project and NOAA management at the contractor's facility.

9.2. MONTHLY PROGRESS REPORT

The contractor shall submit a written weekly progress report. It shall be submitted electronically to a GSFC supplied distribution list. The report shall include instrument status on all instruments currently undergoing manufacturing or testing at the contractor facility. Instrument status should include the past week's accomplishments, the next week's planned activities, any open incident reports existing on that instrument and should track progress against major schedule milestones, including current projected instrument delivery dates. Status of pertinent issues shall also be reported. They include, but are not limited to, open issues concerning the instruments delivered to the MetOp program or the instruments involved in POES spacecraft integration and testing. CCR 1933 MOD 245

The following tables or charts shall also be included:

1. Incident report status showing the total number of open incident reports.
2. Technical action item list and status.
3. Calendar of the present month and following month showing significant events.
4. Business action Item list and status.
5. Proposal Status detailing contract status of proposals and Support Orders.
6. Configuration Management status of open paper work.

9.3. PROJECT ORGANIZATION CHART

The contractor shall provide a detailed project organization chart showing the assignment of key personnel such as the Project Manager, System Engineer, Mechanical, Optical and Electronic Engineers and Quality/Reliability Personnel. The chart will be maintained and updated throughout the contract.

9.4. SCHEDULE REPORTING REQUIREMENT

The contractor shall establish and maintain a schedule control system similar to the one employed during NAS5-30384 and which shall meet the following requirements:

The scheduling system shall show the authorized work in a manner which describes the sequence of work and identifies the interdependencies required to meet the development and delivery requirements of the contract. The format shall be in accordance with the Work Breakdown Structure. The system must be integrated with the contractor's internal control system, and the resolution of the schedule events shall be detailed enough to include printed circuit boards and parts of each of the major subassemblies (but not including electronic piece parts).

Each event shall include (1) the actual starting date, (2) the original planned starting date, (3) the current completion estimate and (4) the actual completion date. Shaded event indicates that it is complete. Schedule status will be included in the monthly report.

9.5. OTHER REPORTING REQUIREMENTS

The contractor shall deliver the following documentation on an as available basis or, at his option, as an attachment to the monthly progress report.

1. One copy of each technical report, which shall include design analysis reports, worst case analysis reports, etc.
2. One copy of each Engineering Change Notice.
3. One copy of each new or revised test procedure.

10. DOCUMENTATION, MANUALS, and PROCEDURES

10.1. DOCUMENTATION FORMAT

Unless otherwise specified, all documentation delivered to GSFC by the contractor shall:

1. Be reproducible.

2. Be plastic spiral-bound, making it easy to disassemble for copying.

3. The plastic spiral-binding shall be light blue in color to provide good contrast for the application of optional labeling of the bindings at NASA with black letters on transparent tape.

4. All drawings or graphs included in documents shall be reduced to 8 1/2 by 11 inch size with or without fold-outs. All drawings and graphs shall be titled, including the serial number of the instrument the data refers to, and dated.

5. The front cover of all documents shall contain:

   A. The document title.
   B. The NASA Contract Number and the GSFC mailing address of the Technical Officer responsible for this contract.
   C. The name, mailing address and telephone number of the contractor.
   D. The publication date of the document.

10.2. DESIGN ANALYSES

When instrument changes become necessary, the contractor shall provide analysis reports to verify his redesign effort.

10.3. MANUALS

10.3.1. Ground Support Equipment (GSE) Instruction Manuals

The contractor shall deliver, where applicable due to an improvement effort the affected, GSE instruction manuals concurrently with delivery of the equipment. An entire set of GSE instruction manuals would be required for the METOP GSE.

10.4. TEST AND CALIBRATION DOCUMENTATION

10.4.1. General

The contractor shall prepare and deliver where applicable a comprehensive set of test procedures for the system, subsystem, and GSE equipment. Updated versions shall be provided as required.

10.4.2. Test Reports

10.4.2.1. Qualification and Final Acceptance Test

The contractor shall organize the results of all tests into reports which will be incorporated into a Final Presentation Data Package (Test Reports) and be delivered one month after the delivery of the instruments.

10.4.2.2. Engineering and Design Tests

The results of any tests that might be required to prove a design concept or might otherwise be termed an engineering test shall be incorporated into Engineering Test Reports and submitted to the Technical Officer on a monthly basis as completed.

10.4.3. Alignment and Calibration Documentation

All alignment and calibration data shall be incorporated into an Alignment and Calibration (A&C) Data Book which is to be delivered one month after the delivery of the instrument. The A&C Data Book shall contain as a minimum a table of channel numbers and corresponding spectra, the FOV plots of each channel, the calibration curves and algorithms of all temperature sensors and the best fit radiometric calibration curves. The book will also include those sections from the instruction manual which pertain to calibration, telemetry conversion, and channel optical prescriptions. Each graph and table is to contain the date of the measurement, the date of the analysis, and the names of those who performed the measurement and the data analysis. All tabular data presented in the A&C Data Book will be submitted on CD ROM in ASCII format. This CD ROM shall include the Microsoft Word version of the Alignment and Calibration Handbook, the NOAA Calibration Data as described in 10.4.4, and the Optical Data as described in 10.4.5. Any update to any of these deliverables shall result in a resubmittal of all deliverables on the CD ROM.

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10.4.4. NOAA Calibration Tapes

Representative calibration data from thermal/vacuum calibration plateaus for each instrument shall be provided on CD ROM. A letter report shall accompany each CD ROM describing the contents of the CD ROM, the data format and any information which would assure the proper interpretation and use of the data on the CD. These data shall be included on the CD ROM as specified in paragraph 10.4.3.

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The contractor shall archive copies of these CD's until the end of this contract.

10.4.5. Optical Data

Graphical data describing the characteristics such as reflectivity and transmission measurements of the individual optical system elements of each instrument shall be provided in as nearly original form as possible. Copies shall have the main parts of the graphs on a single uninterrupted sheet of paper, with skirts attached on separate sheets as required. There shall be sufficient points plotted to adequately describe deflection points and the graphs shall go to zero on each skirt. These data shall also be provided in digital form on CD ROMs. A letter report shall accompany all graphical and electronic data describing the instruments by serial number to which the graphical and electronic data apply, CD ROM data format and any other information required to use these data including a list of serial numbers of all optical components used in each instrument. These data shall be included on the CD ROM as specified in paragraph 10.4.3.

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10.4.6. Instrument Log Book

An instrument log book shall be maintained at the contractors facility which shall contain a chronological record of all instrument activity beginning at completion of system integration and continuing up to instrument delivery. This log will be a permanent record of all events pertinent to the unit including all planned test activity, all engineering test activity which might be required because of anomalous operation, all malfunction report activity and the total instrument operation time.

This record shall be kept current at all times and shall be available for review at any time by any authorized NASA or NOAA representative.

10.4.7. HIRS/3/4 Technical Description

The contractor shall prepare and deliver the HIRS/3/4 Technical Description Document one month after the CDR.

10.4.7.1. Full Size Drawings

The contractor shall from time to time make copies of full size drawings and mail them to the GSFC T.O. as requested by him. A total of up to 200 separate drawings may be required over the period of performance of this contract.

Following delivery of the last flight instrument the contractor shall deliver to the GSFC T.O. one complete, updated, set of full size drawings and specifications.

10.4.7.2. Reduced Size Drawing Books

The Contractor shall provide 4 copies of a separate, reduced size drawing book with drawings reduced in size to 8 1/2 x 11 inches with fold-outs, as required, of all electrical schematics and selected by the GSFC Technical Officer mechanical assembly drawings one month after CDR. The Contractor shall provide updated reduced size drawings as required.

10.4.8. Photographs

The Contractor shall supply 6 sets of 8" x 10" glossy color photographs of all instruments and ground support equipment covered by this contract to the GSFC Technical Officer. Each set of instrument photographs shall record views of the finished instrument from at least three most descriptive angles with the cooler door opened and closed and the scan mirror in different positions where it may be seen in different pictures. There shall be an appropriate number of instrument-disassembled and partially assembled pictures. Pictures shall be numbered, titled and dated on the back of each one. One each, numbered, color negatives shall be provided for each of the different delivered pictures.

10.4.9. Deliverable Documentation and Equipment

Deliverable documentation and equipment shall be as specified in the contract.

10.4.10. Interface Document

The interface documents defining the electrical, mechanical, and thermal interfaces of the instrument with the NOAA spacecraft are the TIROS-N and HIRS/3/4 UIIS. The contractor shall provide updated interface specification information for these documents as required.

(Reference paragraph 10.4.7.2.)

11. GROUND SUPPORT EQUIPMENT REQUIREMENTS

The HIRS/3/4 Ground Support Equipment (GSE) shall comprise the unique equipment required to test, check and calibrate the HIRS/3/4 as well as all equipment required for spacecraft integration, functional operation and checkout during spacecraft system level testing. The GSE from the HIRS/3/4 K,L,M contract (NAS-30384) shall continue to be used, modified or replaced as necessary for use in the HIRS/3/4 instrument assembly and test, both at the contractor's and spacecraft contractor's plant.

11.1. SYSTEM TEST CONSOLE (STC)

The system test console (STC) shall be used to operate the HIRS/3/4 during all testing at the contractor's plant. It shall operate in combination with the BCU to provide power, clock, command and telemetry interfaces which are normally furnished by the spacecraft. The STC shall be capable of recording and analyzing the data received from the HIRS/3/4.

11.1.1. Requirements

1. The STC/BCU combination shall furnish all power, clock frequencies, TIP timing signals and correct slot enable signals, and commands needed by the HIRS/3/4 and normally furnished by the spacecraft. The STC shall be designed to duplicate as closely as possible all interfaces normally supplied by the spacecraft.

2. The contractor shall purchase and design into the STC automatic data processing equipment. The equipment must, at a minimum, be capable of generating self-test programs, command sending and verification programs, limit checks, etc. and analyzing the data from the HIRS/3/4.

3. The contractor is responsible for maintaining the STC including the automatic data system until the end of the contract.

4. The automated data system shall be capable of analyzing HIRS/3/4 data in near real-time during the tests and shall print out the results. At the same time, a continuous record of all data shall be recorded on magnetic tape.

5. Upon selection, the console shall provide a means of decommutating any word or channel data set in the HIRS/3/4 output bit stream and displaying the total decimal count and its channel identification in Arabic numerals on a suitable display. Data other than channel data may be displayed in BCD.

6. The STC/BCU combination shall provide an interface with the HIRS/3/4 calibration blackbodies such that the blackbody temperature circuit data will be automatically entered into the automated data system and/or into the magnetic tape and correlated with the HIRS/3/4 channel radiation data.

7. The STC shall provide tests for all significant HIRS/3/4 and STC voltages and signals.

11.2. BENCH CHECK UNIT (BCU)

The BCU built for contract NAS5-30384 will be used for functional checkout of the HIRS/3/4 at the contractor's plant. The BCU shall be capable of detecting an error in the subsystem, except for detailed checking of radiance levels.

11.2.1. Requirements

1. The BCU shall duplicate all of the spacecraft/HIRS/3/4 interfaces and functions. All input and output impedances, output voltages, and characteristics shall be identical to those of the spacecraft. See TIROS-N GIIS and HIRS/3/4 UIIS specifications for more information on interface characteristics. The TIP analog and Digital B monitors shall be made available on the front panel. In addition, a bench test cooler shall be supplied as part of the BCU.

2. Utilizing the BCU, an operator shall be able to control and monitor the performance of the HIRS/3/4. The BCU does not have to be capable of monitoring every word on a real-time basis.

3. The BCU shall be able to decommutate all words in the HIRS/3/4 data stream. These words shall be able to be printed out in near real time by the test and analysis software. For instance, certain functions such as filter wheel status change shall be available for output for each data stream element. Raw radiometric data shall be available either as the average across a scan line or on a single line element-by-element printout.

4. The BCU shall provide test points for all significant BCU and HIRS/3/4 voltages and signals, not available in the normal data stream.

5. The BCU shall operate from a 115 Volt $\pm$10 %, 60 hertz line.

6. The BCU shall include self test features to insure proper operation.

7. The BCU shall have the capability of printing all real-time data from the D_1 line onto a magnetic tape recorder. The BCU shall have the capability of inserting headers onto the magnetic tape, containing sufficient information to identify the test and other various functions.

8. The BCU shall have the capability of providing uninterruptable power to the STC computer to preclude loss of data maintenance functions during power interruptions.

11.3. CHAMBER TEST EQUIPMENT

The chamber test equipment shall consist of one variable controlled "Earth" blackbody target, one fixed "Space" blackbody target, one "Visible" target, one controller for targets, one Radiant Cooler cold sink assembly with cryo controller, mounting hardware, and cabling. The second set of chamber test equipment, except for cryo controller, will be sent to the spacecraft contractor's facility along with the instrument for all spacecraft level tests. The third set will be sent with the METOP instruments.

11.3.1. Blackbody Calibration Targets

These blackbodies shall be used at the contractor's plant to provide the baseline calibration of the HIRS/3/4 which will be used to demonstrate the flight worthiness of the instrument and to calibrate the on board targets. Actual in flight calibration will be accomplished by the on board targets and space. At the spacecraft contractor's facility, the second set of targets will be used in thermal/vacuum testing to check the instrument calibration.

11.3.1.1. Requirements

1. Location and Mounting The emissive surfaces of the targets in a set shall be identical. In operation, one target will fill the instrument's Field of View in the scan plane positions while the second target will fill the instrument's Field of View from the space look position. The targets will be electrically and thermally isolated from the HIRS/3/4.

2. Effective Emissivity The targets shall achieve a calculated effective emissivity of 0.995 or greater. Their actual emissivity shall be used in calculating the target effective blackbody temperature.

3. Temperature Accuracy The blackbody shall be designed and installed so that the temperatures measured with platinum thermometers, placed in selected areas of the radiating plate will be representative of the effective blackbody temperature to within +0.05°C. These targets may be reworked to include recalibratable sensors.

4. Gradients The target shall be designed so that the effective surface temperature over the area received by the instrument shall be uniform to within +0.075°C at any temperature in the operating range. It shall be monitored at sufficient points to demonstrate this uniformity.

5. Operating Temperature Range The effective blackbody radiating surface temperatures shall be controllable over the range 180°K to 340°K in vacuum. The fixed target shall operate at a temperature below 90°K.

6. Controlled Temperature Stability The targets shall be able to stabilize at the specified temperatures to within +0.1°C.

7. Amplitude of Controller Cycling The controller cycling amplitude shall not exceed +0.05°C.

8. Cooling The variable target and controller shall attain a controlled target temperature in vacuum of 180^{o}K or lower within approximately six hours after start-up of cooling from +25^{o}C. The fixed space reference target shall attain a stable temperature within six hours after the cryogenerator is turned on.

9. Step Change The target and controller shall be designed so that the target temperature can be increased in +30^{o}C increments and reestablished within 3 hrs maximum +0.1^{o}C of the desired temperature in the target temperature range from 180^{o}K to 260^{o}K, when LN2 is used as the coolant. From 260^{o}K to 340^{o}K, one hour shall be sufficient to increment and stabilize the target temperature.

10. Thermal Off-Loading The design of the variable target shall be such that when it is at 180^{o}K for a period of one hour, the change of temperatures anywhere within the HIRS/3/4 shall not exceed more than +3^{o}C from the norm (spacecraft interface temperatures held constant).

11. Temperature Sensor Requirements The temperatures of the targets shall be measured with platinum resistance thermometers. The sensors will be placed in the target radiating surface at positions which will represent the temperature seen by the instrument. The contractor shall design and supply circuitry to read out the platinum sensors. The sensors shall be powered and read out through the system test console. The PRT sensor readout shall be designed to be sampled and formatted onto magnetic tape along with the instrument data. The temperature readout circuitry shall be designed to achieve an accuracy of +0.05^{o}C. The platinum wire sensor leads shall be electrically isolated from all other parts of the target.

11.3.2. Target Temperature Control Unit

The contractor shall use, upgrade as required and maintain two control units for the "Earth" blackbody targets. The control unit shall be designed to drive resistance type heaters operating against a liquid nitrogen (LN2) or cooled brine heat sink.

11.3.2.1. Control Console

The target console shall be capable of controlling the variable target independently and shall have independent digital temperature readout equipment with a resolution of +0.05^{o}C. The console when used at the instrument contractor's facility shall have the provisions to read the target temperatures into the STC. The console when used at the spacecraft contractor's plant, must have complete facilities for controlling the variable target temperature as well as discrete outputs for monitoring each platinum resistance thermometer, the temperature set point (console knob position) and the target status. All signals shall be fed out through a connector as differential pairs (signal plus reference) suitable for sampling by a digital voltmeter. In addition, the console shall contain a test point and selector switch so that any output can be individually monitored.

11.3.2.2. Cables

The contractor shall use and maintain all cabling provided for operation of the control consoles including those cables delivered with the console to the spacecraft contractor's facility. The required lengths of the chamber external and internal cabling shall be defined by the spacecraft contractor. All equipment sent to the spacecraft contractor's facility shall meet the additional requirements called out in the TIROS-N GIIS.

11.3.2.3 Target Controller for Spacecraft Thermal Vacuum Testing

A heater control circuit shall be provided for the Earth shield heater, the motor housing target heater and the earth target heater that shall individually control the heaters from the control console. The earth shield heater and the motor housing target heater shall maintain the temperature of the shroud/radiant cooler inner panel facing the HIRS cooler door and the motor housing, respectively, to 0 ± 5°C during the spacecraft thermal vacuum testing. The earth target heater controller shall maintain the earth target temperature to ± 2°C over the range of temperatures from –93 to +47°C for a duration of 20 minutes. The earth target controller shall individually control the earth target wall and base heater using a dedicated temperature sensor (PRT).

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11.4. OPTICAL BENCH TEST FACILITY

The contractor shall use and maintain the government furnished optical bench suitable for performing the instrument alignment and alignment checks as well as all the required optical tests. The optical bench facility shall have a collimator designed such that its entrance aperture is maintained at ambient temperature when used with a large aperture high temperature radiation source and shall be such that it does not add errors to the required testing.

11.5. BENCH COOLER

The Bench Cooler is fabricated such that it will allow stable radiant cooler operation on the bench at its nominal control point of $100.0^{o}K \pm 2K$. This unit will be used at the contractor's facility to perform instrument alignment and radiometric checks, gain sets, etc. outside the vacuum chamber.

11.6. AMBIENT STIMULI EQUIPMENT (ASE)

The Ambient Stimuli Equipment (ASE) includes a blackbody radiation source that is controllable at any temperature between $+20^{o}C$ and $+60^{o}C$. The ASE will be used to rough set gain outside of a vacuum chamber and for quick response checks at the instrument contractor's facility.

11.7. SOFTWARE

Existing software shall be used to the maximum extent practical. The contractor shall provide all required computer programs which will be used in the processing and interpretation of the test and calibration data. These shall include, but not necessarily be limited to the following: an instrument calibration program, a Field of View program and a limits program.

11.8. WITNESS MIRRORS

The contractor shall place at least one removable witness mirror in the thermal vacuum chamber during the testing of the HIRS/3/4.

11.9. PORTABLE SUITCASE TESTER

The contractor shall design and produce a portable suitcase tester (PST) which will be used for functional checkout for the HIRS/3/4 by the contractor and at the spacecraft contractor. The tester shall be designed to operate on both 115VAC 60 Hz and 220VAC 50Hz & in accordance with the following requirements:

1. All interface circuits in the suitcase tester must be electrically equivalent to the corresponding spacecraft interface circuits.
2. External power supplies may be used.
3. Separate lines from the supply with overall over voltage and individual current limiting protection should be provided for the 28V pulse and the 28V regulated bus.
4. On/off switching must be provided for all power sources.
5. Each power line must have a provision for current sampling.
6. Provide outputs for all analog TM.
7. Provide display for Digital B TM which indicates the command status of the instrument.
8. Provide a command generator capable of sending any command to the instrument by manual control.
9. Provide all clock and synchronization signals necessary to operate the instrument.
10. Provide access to multiplexed video for the SW, LW and visible, to demonstrate instrument aliveness.
11. Provide access to all points on the instrument test connectors. Short circuit protection must be provided.
12. Self testing where practical should be incorporated into the design.
13. Provide a descriptive manual including all circuit diagrams and complete operating instructions.

11.10. DATA COMMUNICATIONS

Maintain capability to transfer instrument data to and from the main computer shall be provided. An IBM compatible computer system connected to the main computer via an RS232 line shall be provided to accomplish this. The IBM compatible computer shall also be connected to a telephone modem compatible with that used by the GSFC T.O. Software shall be provided as required for data communications between the IBM computer and the GSFC T.O.

12. CONFIGURATION MANAGEMENT

12.1. PROGRAM AND PLAN

The contractor shall maintain and implement a Configuration Management Program similar to and in accordance with ITT Document No. CMP-16603.

The Configuration Management system shall be maintained throughout the life of the HIRS/3/4 contract. It shall provide (1) at any one time the capability of accounting for the actual firm design in existence, (2) for an orderly and well defined method of implementing and documenting approved changes, and (3) GSFC review and/or approval of proposed changes.

12.2. CLASSIFICATION OF CHANGES

Proposed changes which require either review or approval by the GSFC TIROS Project Configuration Control Board (CCB) shall be classified as in the following paragraphs:

12.2.1. Requires GSFC Approval

Class I change - Any change which impacts the GSFC TIROS Project's technical performance requirements, technical interfaces, cost and schedule requirements.

12.2.2. Requires GSFC Review

Class II change - A change shall be classified Class II when it does not fall within the definition of a Class I change. Examples of a Class II change are:

A change in documentation only (e.g., correction of errors, addition of clarifying notes or views); or change in hardware (e.g., substitution of an alternative material or "make play" changes) which does not affect any factor listed under Class I changes.

Class I changes originated by contractor shall be documented on a TIROS Configuration Change Request, GSFC 480-39, and submitted to the GSFC TIROS Project CCB for approval prior to implementation.

Class II changes originated by the contractor, and approved by the contractor's CCB shall be submitted on the contractor's internal change forms for GSFC review. Class II changes do not require GSFC concurrence prior to implementation.

12.3. CONFIGURATION MANAGEMENT DOCUMENTATION

Configuration management program status reports shall be submitted by the contractor as part of the monthly progress report. Documentation shall be submitted as specified in the contract, subject to actions be GSFC as indicated.

13. TEST AND CALIBRATION REQUIREMENTS

13.1. GENERAL REQUIREMENTS

The contractor is required to demonstrate by practical test and calibrations that the items produced under the contract meet all the requirements of this specification. He will, as a minimum, perform the tests and calibrations outlined below.

13.1.1. Test and Calibration Procedure

As a minimum, the contractor shall prepare test and calibration procedures covering the requirements of this specification. Preliminary test and calibration procedures shall be submitted to the Technical Officer for review with the monthly reports. The tests and calibrations must be sufficient as judged by the Technical Officer to obtain all information needed for full interpretation of the data. The test and calibration procedures (excluding schedules) shall be submitted to the T. O. at least 3 months before testing or calibrating will commence.

13.1.2. Documentation of Tests and Calibrations

The contractor shall organize the results of all tests into test reports which shall be submitted within one month after instrument delivery. He shall also organize and maintain test and calibration data books which shall become a record of all tests which could aid in interpretation of the orbital data, and all calibrations made for the instrument. A summary section shall be prepared for each record book which contains functional equations and charts depicting the final calibrations of the instrument and every other subsystem output as determined from all tests performed.

13.1.3. Performance Checks

The contractor shall perform a bench check of the instrument immediately before and after each of the qualification or acceptance tests specified.

13.1.4. Retesting

In the event of a failure during qualification testing or acceptance testing, the contractor may be required to rerun the complete test starting at the beginning of whichever test the failure occurred. The exact nature of retest shall be determined jointly by GSFC and the contractor.

13.1.5. Limits Program

The contractor shall develop a program to monitor all functions of the HIRS/3/4 on a real-time basis. Certain functions shall be designated as critical, and the program will be designed to alert the operator if intervention is required. The program shall be designed to verify all operational modes of the scan and print out any out of tolerance items. This program will normally be used during acceptance thermal-vacuum testing of the flight models. It will be used anytime the instrument is being operated from the System Test Console (STC).

The program shall also be capable of printing out the standard deviation, maximum and minimum spectral interval response, and all temperature monitors for a given scan line.

The contractor shall use the program to thoroughly check the subsystem data outputs. It will be used to detect intermittencies and failures during extended periods of automatic system operation with constant stimuli. It will monitor all prime data, verify that they remain between present limits, and check format, sign and parity. It will log all discrepancies detected using the printer and will shut down the system in case of critical failures.

13.1.6. Flight Acceptance Magnetic Field Test

The contractor shall support NASA efforts to determine the instrument-generated magnetic field and instrument magnetic susceptibility if configuration changes warrant such testing.

13.1.7. Trouble-Free Performance Testing

By the conclusion of the environmental test and calibration program, the instrument shall have operated for at least 50 hours trouble-free.

14. SYSTEM PERFORMANCE TEST REQUIREMENTS

14.1. ELECTROMECHANICAL DESIGN TESTS

The contractor is required to submit a test plan for verifying the flight worthiness of any subassembly which has changed significantly from the HIRS/3/4 configuration. If a special model is constructed for a specific test, as for example, a subassembly vibration test, it must be identical to the proposed flight subassembly, and all operating parameters shall conform to this specification.

14.2. SUBSYSTEM ELECTRONIC TEST

For each signal path the contractor shall perform laboratory tests of the drift, linearity and gain stability of the PC boards containing the analog and/or digital signal electronics at 0^oC, $+50^oC$ and ambient. The video subsystem, is to be tested between 0^oC and $+30^oC$.

14.3. SYSTEM OPTICAL TESTS

14.3.1. Optical Alignment

The contractor is required to design a test to perform and check the optical alignment of the system. This test shall be part of a general optical and electrical performance test which shall be performed before and after any test that might change the optical alignment; e.g., the vibration test.

14.3.2. Relative Spectral Response

The relative total spectral function of each channel shall be determined to an accuracy of $0.5cm^{-1}$. These data shall be included in the final alignment and calibration data book. The contractor shall submit the manufacturer's spectral response test results of each element of the optical path including detectors so that the total spectral response can be determined. This information shall be included in the Alignment and Calibration Data Books.

14.3.3. Out-of-Band Spectral Response Tests

The response of each spectral channel to integrated radiation outside the normal spectral bandpass shall be determined by the measured spectral response of the individual elements. The total integrated out-of-band spectral response as referenced to a 330^oK blackbody shall then be calculated. The above calculations and determinations shall be performed only if there is a change to the spectral filter blocking design from the HIRS/3/4 contract. Vendor tests on the spectral filters may be expanded versions, as specified in the foregoing, of those performed on the previous HIRS/3/4 contract. Vendors shall now supply spectral filter measurements in both graphical and numerical data listings in both hardcopy and IBM-compatible PC diskette form.

14.3.4. Field-of-View Wings

If there is a design change for the HIRS/3/4, the contractor shall perform a test to demonstrate that at least 98% of the total energy lies within a 1.8^{o} Circle.

14.3.5. Out-of-Field Radiance Test

The contractor shall perform a test on the first HIRS/3/4 optical train, not including the scanner. This test is to include the effects of spacecraft shadowing to measure any potential effect of radiant sources outside the normal Field of View of 1.8^{o}.

14.3.6. Scan Alignment

The actual angular direction of the center of the visible FOV's shall be determined with the scan mirror in the Nadir, Scan Step 0 and Scan Step 55 positions.

14.3.7. Thermal/Vacuum Testing

14.3.7.1. General Thermal Tests

The contractor shall design and perform any required special thermal/vacuum tests to confirm the instrument's thermal design. The instrument shall be mounted as it will be on the spacecraft to a temperature controlled interface. Lamps, heaters, and cooled shields will be used to simulate the expected in-orbit radiational environment including transients. See Figure 4. for the flight acceptance thermal/vacuum profile. There shall be no calibration shifts between the beginning and end of thermal/vacuum testing; absolute counts and intercepts may vary, but slope data will repeat within $\pm$1%. The count level (equivalent radiance) for the space look, will always be equal to or less than counts from the earth target when it is cooled to liquid Nitrogen temperature.

14.3.7.2. Shutdown and Re-start Tests

These tests have been removed as requirements by Modification 13 to Contract NAS5-30384, with the reservation that they can be reimposed if necessary.

14.3.8. Portable Tester Tests

The portable tester shall be used by the contractor to operate and check out HIRS/3/4 instrument whenever a limited quick-look test is needed for trouble shooting. The portable tester may be used at the spacecraft integration contractor's plant for acceptance tests of the HIRS/3/4 instrument during incoming inspection for periodic subsystem checks, and for trouble shooting when and if problems occur, as well in connection with the vibration testing, the EMI testing, and during final delivery testing.

14.3.9. Ground Support Equipment Tests

The contractor shall design and perform tests to demonstrate that the GSE is functioning properly and within specification.

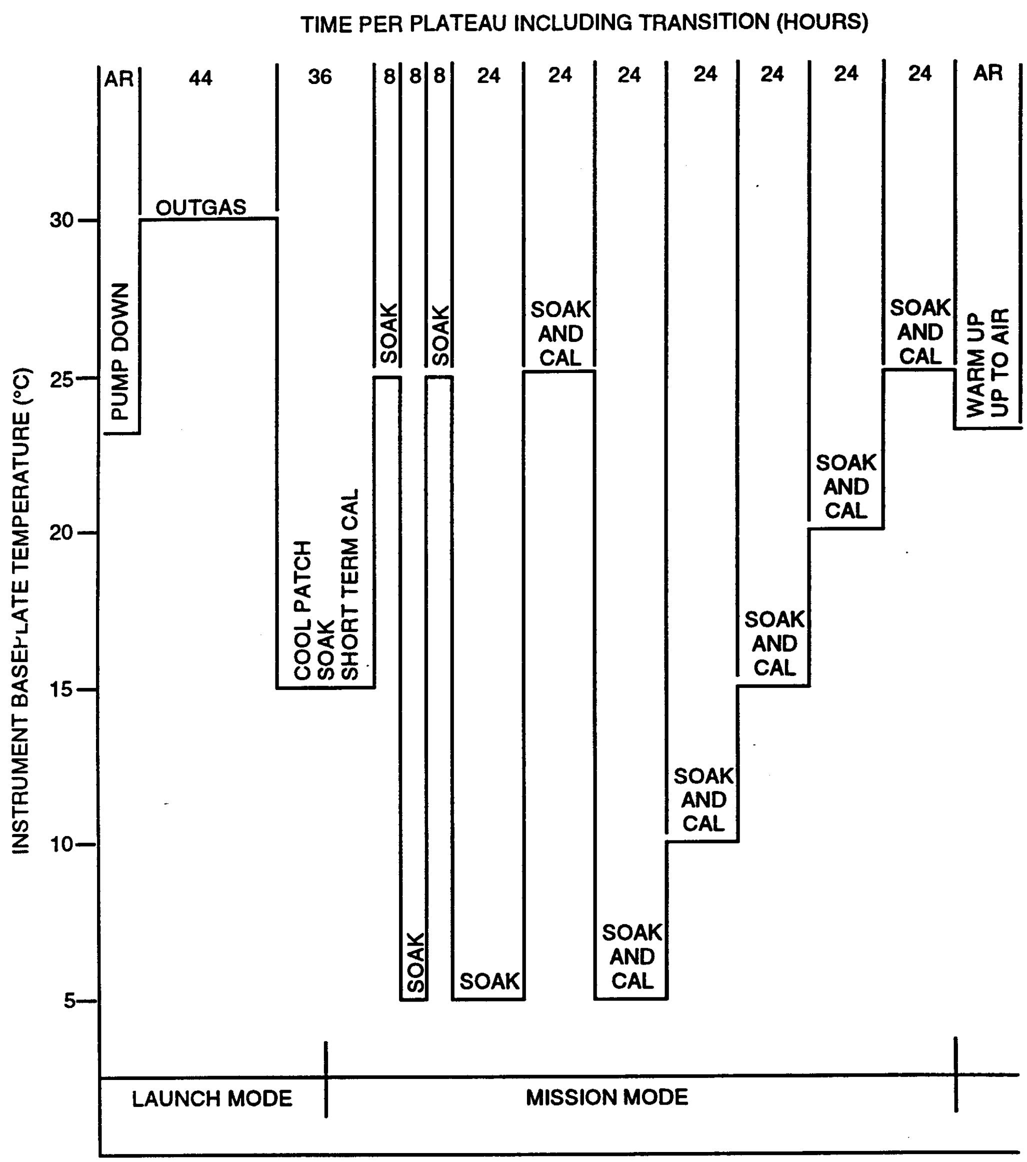

Figure 4. Flight Acceptance Thermal Vacuum Profile

14.4. SYSTEM CALIBRATION TEST REQUIREMENTS

14.4.1. General

The determination of spectral response vs. scene radiance of each channel will be the most comprehensive test of the system design and performance. This test must be capable of producing the information needed for processing the data gathered in orbit. The calibrations will be planned to (1) demonstrate subsystem performance, (2) provide a calibration of the spectral radiances of the on-board blackbodies with an external blackbody as reference, and (3) provide the data from which the initial regression coefficients, used to compute the slope and intercept which define the gain for each channel, can be determined. The regression coefficients are a function of known instrument component temperatures, slope, and intercepts measured and computed from many calibration cycles at different temperatures.

It is also required that all temperature and voltage monitors be calibrated. Equations as well as data tables are to be provided for all monitors as a function of the HIRS/3/4 output. The traceability of calibrations to NBS standards shall be documented where applicable and included in the Alignment and Calibration Data Book.

14.4.2. Results of Calibrations

The results of the calibrations shall be summarized by the contractor in the alignment and calibration data book. The information listed below shall be derived from the calibration data:

1. (NEdN) - Noise equivalent spectral radiance for measurements in each channel.
2. Standard deviation of individual calibration points from the best fit calibration curves for each channel and each calibration.
3. Linearity of calibration curves for each channel and each calibration.
4. Calibration of in-flight calibration blackbodies in terms of effective temperature versus temperature monitor bit outputs.
5. Calibration curves of all thermistors.
6. Calibration of all voltage monitors.
7. Calibration of all platinum resistance thermometers.

14.4.3. Response Calibrations

14.4.3.1. General

The contractor shall calibrate and test the instrument and/or perform calculations as approved by the Technical Officer to determine the response calibrations and all significant corrections to those calibrations for the full-expected range of instrument interface temperatures, detector temperatures, and scan angles. The effective temperature of the in-flight blackbody shall be determined as a function of its temperature monitor outputs by comparison with external calibration blackbodies. The contractor shall plan and conduct a test program which will produce the information required to evaluate the orbital measurement with a (NEdN) precision equal to or less than the required values.

The calibration plans shall include the items outlined below, but need not be limited to them. The calibration environment for the instrument shall simulate the mean mission thermal radiation environment. The instrument shall be tested with its full complement of shields and insulation.

14.4.3.2. IR Channel Calibration Requirements

Radiance response calibrations and calibration checks of the IR channels shall be made at the following five instrument baseplate T/V temperature plateaus: +5^{o}C, +10^{o}C, +15^{o}C, +20^{o}C, and +25^{o}C, $\pm$1^{o}C. The +25^{o}C calibration soak shall be done before the 5^{o}C soak and after the +20^{o}C soak. At each temperature plateau, the external calibration target shall be cooled to 180^{o}K at the start of calibration and calibration runs made at a minimum of 7 intermediate target temperatures up to 340^{o}K before the instrument temperature is raised to the next plateau. The target temperature shall be set to its preselected value $\pm$1^{o}K and stabilized sufficiently to meet the following target temperature requirements: The target temperature is determined from the mean of the several platinum sensors imbedded in it. During the period that calibration data are taken, the indicated target temperature change of each platinum sensor taken individually shall be less than 0.1^{o}K. In other words, if any platinum sensor indicates a target temperature change of 0.1^{o}K or greater during the calibration run, all data for the run will be discarded. At least 200 samples of calibration data will be taken for each channel at each target temperature at each instrument plateau. After each calibration run, the instrument will be put in an interrupted internal calibration mode and a minimum of 200 samples each taken for both internal targets and the space target.

14.4.4. Special Thermal/Vacuum Data Requirements

During the thermal/vacuum portion of the instrument acceptance test, a separate data tape will be prepared either from the master data tape or from a separate simultaneous recording. This data tape shall be changed at appropriate places during the thermal/vacuum cycle, (i.e., after the initial cool down, after each calibration plateau, etc.) and a copy forwarded within 2 months after the test is completed to the Technical Officer along with supporting documentation of the tape contents and format.

14.4.5. Instrument Calibration Program

The contractor shall generate a calibration program which will: (1) generate a history tape during the time that the calibration is in process and (2) perform an analysis on the history tape at the completion of the calibration. The history tape shall be copied and one copy and supporting documentation shall be sent to the GSFC T.O. and one copy stored separately at the contractor's facility until the end of the contract.

The program and its documentation shall be delivered to the government at the end of this contract. The Alignment and Calibration Books shall be delivered one month after delivery of the instrument.

The history tape shall contain a header with the instrument number, date, test conditions, and any other pertinent information. The target temperature monitors shall be inserted at the correct time on the history tape. All raw data shall be contained on the history tape.

The analysis of the calibration history tape shall accomplish and print out the following:

1. The mean and standard deviation of the raw data (in counts) shall be determined for each external target temperature at each instrument temperature plateau for each IR channel and printed out along with the maximum and minimum value of each data set, the number of samples taken, and the scene radiance calculated for each channel from the external blackbody target temperature.

2. At each instrument temperature plateau and for each IR channel, the best straight line fit to all the raw data points shall be determined using a least squares approximation. The independent variable shall be bits and the dependent variable shall be radiance. The slope and intercept of this best fit shall be printed out.

3. At each external target temperature during a calibration run, the temperature of each of the platinum sensors in the targets shall be calculated. The mean of five of the six ECT sensors data is printed out. The ECT sensor data shall be sampled each scan line (once each 6.4 sec) and the average data from 5 sensors used in the report.

4. At each external target temperature, all internal temperature sensor data shall be printed out.

5. For each instrument baseplate temperature plateau and for each IR channel, the standard deviation of the actual data from the data predicted by the best fit straight line shall be computed for each external target temperature.

6. The mean and standard deviation of the internal target and space target data shall be computed and printed out for each set of data taken, i.e., each external target temperature.

14.5. TEMPERATURE AND VOLTAGE MONITOR CALIBRATIONS

14.5.1. Temperature Sensor Calibrations

14.5.1.1. Temperature Circuit Calibrations

The contractor shall use thermistors that have a 0.5 percent interchange ability. The contractor shall use 0.1 percent tolerance resistors in the thermistor circuits, and the circuit voltages shall be regulated and read out. Calculated calibrations for each type of thermistor circuit shall be furnished. The circuits readout shall be calibrated in terms of output bits versus temperature in ^{o}C. Those readout as spacecraft analog data shall be calibrated in terms of volts versus temperature. The calculations shall include a self-heating effect of power dissipated in the thermistors. The thermal/vacuum test data shall be examined to detect obvious discrepancies in thermistor circuit calibrations, and abnormal components shall be replaced. The temperature range covered by the thermistor shall be $\pm 3^{o}$C on each side of the expected range.

14.5.1.2. Platinum Resistance Thermometer (PRT) Calibrations

The contractor shall provide calibrations of the platinum resistance thermometers. Prior to the final assembly of the HIRS/3/4, each platinum resistance thermometer output shall be calibrated over the normal temperature range at which it is expected to operate. A transfer standard will be used for system calibration. The traceability to NBS standards shall be documented and included in the Alignment and Calibration Data Book.

14.5.1.3. Platinum Resistance Thermometer Circuit Calibrations

The contractor shall furnish calibrations of the platinum resistance thermometer circuits in terms of bits versus PRT resistance and will calculate and measure the calibration for each PRT in its circuit in terms of bits versus temperature (^{o}C).

14.5.2. Voltage Monitors

The contractor shall determine and furnish calibrations for the prime data voltage monitor circuitry in terms of bits and for the spacecraft analog voltage monitor circuitry in terms of volts.

*** END ***

APPENDIX A
GLOSSARY

APPENDIX A
GLOSSARY

ABPL	As-Built Parts List
AC	Actual Cost
ADC	After Date of Contract
AMSU	Advanced Microwave Sounding Unit
AOC	After Award of Contract
ARO	After Receipt of Order
AVHRR	Advanced Very High Resolution Radiometer
BCWP	Budgeted Cost of the Work Performed
BCWS	Budgeted Cost of the Work Scheduled
BCE	Bench Check Equipment
C	Centigrade
CCB	Configuration Control Board
CDR	Critical Design Review
CM	Configuration Management
CONFIG.	Configuration
CPM	Critical Path Method
DPA	Destructive Physical Analysis
EEE	Electrical, Electronic and Electromechanical (part)
EM	Engineering Model
EMI	Electromagnetic Interference
ETM	Engineering Test Model
FM	Flight Model
GE/ASD	GE/ASD Astro-Space Division
GFE	Government Furnished Equipment
GIDEP	Government-Industry Data Exchange Program
GIIS	General Instrument Interface Specification
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HIRS/3/4	High Resolution Infrared Radiation Sounder/3/4
IMP	Instrument Mounting Platform
INSTR.	Instrument
LM	Lockheed Martin
K	Kelvin
METOP	Name of the European Meteorological Satellite(not an acronym)
MGT.	Management
MRB	Material Review Board
NASA	National Aeronautics and Space Administration
NESDIS	National Environmental Satellite, Data and Information Service

APPENDIX A (Continued)

GLOSSARY

NOAA	National Oceanic and Atmospheric Administration
NSPAR	Nonstandard Parts Approval Request
NSPL	NASA Standard Parts List
O&M	Operations and Maintenance
OTM	Optical Test Model
PA	Performance Assurance
PAR	Performance Assurance Requirements
PC	Personal Computer
PDR	Preliminary Design Review
PER	Pre-Environmental Review
PF	Proto flight
PFM	Proto flight Model
PPL	Preferred Parts List
PRT	Platinum Resistance Thermometer
PSR	Pre-Ship Review
S/C	Spacecraft
SCDR	System Concept Design Review
SCR	System Concept Review
SOW	Statement of Work
STU	Special Test Unit
TCE	Temperature Control Electronics
TM	Telemetry
TMP	Temperature
TO	Technical Officer
TOVS	Tiros Operational Vertical Sounder
UIIS	Unique Instrument Interface Specification
WBS	Work Breakdown Structure

APPENDIX B
APPROVED DEVIATIONS AND WAIVERS

Deviation/ Waiver No.	CCR No.	CCR Approved Date	Section/ Effectivity	Description
W-9	1024	7/24/90	Table 1 H301, H302, and H303	Integrated Center Frequency is 1536.6 cm^{-1}, should be 1527.0 to 1535.0 cm^{-1}. Center Frequency for uniformity test is 1535.13 to 1535.33 cm^{-1}, should be 1535.0 cm^{-1}.
D-25	1090	12/20/91	11.3.1.1-3, 11.3.1.1-4 H301, H302, and H303	The Blackbody Calibration Target, provided as GFE, is non-compliant to the requirements specified in S-480-28.2, Revision B. The areas of noncompliance are the Temperature Accuracy (para. 11.3.1.1-3 and the Gradients (para. 11.3.1.1-4) as shown in the following table: Spec. @180K @295K @340K Accuracy 0.05^{o}C 0.23^{o}C 0.04^{o}C 0.06^{o}C estimate Gradient 0.075^{o}C 0.77^{o}C 0.079^{o}C 0.13^{o}C measure (HIRS/2I FM3I) The continued use of the calibration target ∀as is∀ is requested.
W-32	1165	7/8/93	7.5.2 H301	Registration of the centroid of Channel 17 with respect to Channel 19, the SW reference channel, exceeds the $\pm$1% FOV half power diameter requirement. It is 1.3%. The cause is that the transmission through the Channel 17 spectral filter is nonuniform from one side of the filter to the other. See waiver for uniformity plots.

Deviation/ Waiver No.	CCR No.	CCR Approved Date	Section/ Effectivity	Description
W-33	1125	9/30/92	7.3.1 H302 and H303	Flight Models 302 and 303 are expected to have longwave FOV diameters that are below spec. minimum. This is due to a transmission rolloff with incidence angle in the aplanat lens that is mounted on the longwave detector. The approximate FOV values with a LW HIRS/3 detector installed in FM301 are shown in the following table:

Channel	Approximate FOV Diam. expected in H302 & H303 (degrees)	Specification (degrees)
1	1.229	1.28 to 1.5
2	1.216	1.3 to 1.5
3	1.218	“
4	1.221	“
5	1.203	“
6	1.222	“
7	1.215	“
8	1.252	“
9	1.305	“
10	1.205	“
11	1.298	“
12	1.313	“

Channel	NEDN H302 (Predicted)	NEDN H303 (Predicted)	Specification
1	0.338	0.450	3.000
2	0.116	0.155	0.670
3	0.089	0.118	0.500
4	0.063	0.085	0.310
5	0.052	0.071	0.200
6	0.054	0.073	0.240
7	0.038	0.052	0.200
8	0.011	0.017	0.100
9	0.017	0.026	0.150
10	0.038	0.056	0.160
11	0.023	0.026	0.200
12	0.024	0.022	0.200

Deviation/ Waiver No.	CCR No.	CCR Approved Date	Section/ Effectivity	Description
W-40A	1166	7/8/93	7.5.2 H301	The half power FOV size of Channel 1 is 1.27° against a spec. requirement of 1.28° minimum. The registration of the FOV Centroid of Channel 1 with respect to Channel 8, the LW reference channel, is 2.3% against the requirement of ±1.5% of the Channel 8 half power FOV width.
W-42	1167	7/8/93	Table 1 H301	The half bandwidth of the finished part, 12.9 cm^{-1}, is below the specified value 16 ± 4/2 cm^{-1}.
W-43	1168	7/8/93	Table 1 H303	The center frequency is 1034.3cm^{-1}. which is above the specified value of 1030 ±4 cm^{-1}.
W-44A	5001	3/14/94	7.5.2 H302	Centroid of Channel 17 with respect to Channel 19 is displaced such that the registration is 1.7% against the spec requirement of 1.0%. The halfpower diameter of the IFOV is 1.9% below the size of Channel 19 against a 1.0% requirement. Both results are due to a non-uniform transmittance across the width of the Channel 17 filter. (IFOV cross section and registration plots for both Channel 17 and 19 are attached.)
W-48	5000	3/14/94	7.5.2 H302	The half power IFOV size of Channel #9 when matched with the LW Reference Channel #8 exceeds the +5 % requirement. The half power FOV sizes of Channels #13, #14, and #20 when matched with the SW reference Channel #19 exceed the +1% requirement. Tables 1 & 2 attached to waiver give the post vib test results.
W55-A	1287A	12/8/94	7.5.2 H303	The half power IFOV size of Channel 9 when matched with the Longwave Reference Channel 8 exceeds the 5% requirement. Channel 20 half power FOV size when matched with the Shortwave Reference Channel 19 exceeds the 1% requirement. Table 1 contains the post-vibration test data.
W56-A	1286A	12/8/94	7.5.2 H303	Channel 13 centroid registration with respect to Channel 19 is 1.12%. The requirement is 1%.

Deviation/Waiver No.	CCR No.	CCR Approved Date	Section/Effectivity	Description
W-58	1299	12/20/94	5.18.2.2 H303	The radiator window heaters in the radiant cooler are powered from the +28V Reg Bus, but their return path is to the +28V Filter Wheel Pulse Bus return. In effect, this gives about 8KΩ of isolation between these two data buses whereas GSFC S480-28.2 requires 5MΩ and IS3267415 requires 100KΩ minimum (an apparent specification conflict). (See M. Braun memo and G. White/S. Gregg teleconference).
W-59	1325	07/12/95	6.1.13.5 H304 and H305	GSFC-S-480-28.2 para. 6.1.13.5 requires the contractor to prepare and furnish a materials and process list for materials used. It will categorize all materials listed as metals, plastics, coatings, miscellaneous, and etc., and adequately identify the item the government specification, process, cure cycle, type, chemical composition and/or manufacturer. The listing shall also specify the application(s) of each material in the subsystem. Request acceptance of nondisclosure of proprietary materials (steel alloys) and their corrosion preventative coatings for use defined by SMI assembly drawing 101845 and proprietary fabrication drawings 103408 stator lamination and 103932 rotor lamination which are based on extensive space flight and qualification heritage on previous NASA programs for more than 28 years. Materials & Process Lists which contain these proprietary items have been accepted by other prime contractors and NASA.
N/A	1512	11/26/97	5.6.3.4 H302	The H302 instrument exceeds the 2% allowed ripple on the 28 VDC regulated bus performance ranges from 4.5-5%
101	1569	07/17/98	7.3.1 H305	Field of View (FOV) size for Longwave channel 1 is below specification limits. All channels required to be 0.69 +/-0.04 deg. Channel 1 is 0.64 deg.
TDR K1504, TDR K1505, TDR K1506	1521	02/11/00	3.1.3.2.6.1, 3.1.3.5.5, 3.1.3.4.6.3	Based oupon tests performed at the SC contractor's facility, H303 failed to meet the 28 VDC ripple requirements: measured 9.2 ma compared to specification of plus or minus 6.2 ma.
112	1639	06/17/99	Table	The amount that the center frequency is out of spec is minimal and on the order of the measurement/calculation resolution.
130A	1818	10/30/01	3.1.3.2.6.1 H306	These emission levels are in family with all previous HIRS instruments, and similar waivers have been submitted in the past (ref. Waivers 92A and 93).
N/A	1872	10/30/01	5.6.3.4	The 28 V DC ripple measured 15 ma compared to 6.2 ma specification.